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THE
GENTLEMAN
FARMER.

BEING
AN ATTEMPT TO IMPROVE
AGRICULTURE,

By subjecting it to the Test

OF
RATIONAL PRINCIPLES.

THE SECOND EDITION,

With considerable ADDITIONS.

Semper ego auditor tantum? Juv.

EDINBURGH:
PRINTED FOR JOHN BELL.

M,DCC,LXXIX.

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AGRICULTURE
CAN ATTEMPT TO IMPROVE

By subjecting it to the Test



THE SECOND EDITION

With cordials A. D. 1705.

U.S. DEPARTMENT OF AGRICULTURE

EDWIN

FOR JOHN B. LLOYD

DECEMBER 1961

E P I S T L E

Sir JOHN PRINGLE,
President of the ROYAL SOCIETY.

THERE are few persons who
rival Sir John Pringle in
my esteem: there are still fewer
whose friendship I value more. It
is not, however, my purpose in this
letter, to proclaim these things to
the world; for what concern has
the world with private connec-
a 2 tions?

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tions ? Ambition to have the patronage of the Royal Society to this work, is my motive for addressing you in this public manner. The plan it recommends, has been my guide many years; and success has left me no doubt of its solidity. Your sanction, my friend, will ensure it a gracious reception, from a body of learned men, who have distinguished your literary merit by the greatest honour they have to bestow. It is my fervent desire to be useful to my country; the stamp of that illustrious Society, will give a currency to the work :

every

EPISTLE. IV.

every one will read; and every sensible farmer will profit by it.

Agriculture justly claims to be the chief of arts: it enjoys beside the signal pre-eminence of combining deep philosophy with useful practice. The members of your Society cannot employ their talents more profitably for their country, nor more honourably for themselves, than in promoting and improving an art, to which Britain fundamentally is indebted for the figure it makes all the world over.

The

P. R. E.

vi E P I S T L E.

The theory here suggested, is in some measure new: it belongs to the Royal Society to determine, whether it be founded on solid principles. It will give me entire satisfaction, to be countenanced by a Society, which has contributed more to promote natural knowledge, than any other society existing, or that ever did exist.

Your, &c.

HENRY HOME.

P R E-

P R E F A C E.

BEHOLD another volume on husbandry! exclaims a peevish man on seeing the title-page: how long shall we be pestered with such trite stuff? "As long, sweet Sir, as you are willing to pay for it: hold out your purse, and wares will never be wanting."

It must indeed be acknowledged, that the commerce of books is carried on with no great degree of candour: those of husbandry, with very little. A bookseller contrives a new title, collects books upon the subject, delivers them to his author to pick and cull; and, "Here, Sir, is a spick and span new work, full of curious matter." Agriculture is the prime of arts: every thing is made welcome on that subject; and provided the title be new, it is to the bookseller of no great importance, how threadbare the contents be.

Writers on agriculture, very few excepted, deliver their precepts from a study lined with books, without even pretending to experience. Principles and propositions are assumed on the
authority

authority of former writers : opinions pass current from generation to generation ; and no person enquires whether they wear the livery of truth. Take the following short specimen, drawn from a single head, that of manures. Writers talk learnedly of lime, stone-marl, clay-marl, shell-marl, and of other manures ; and foretel how they will operate upon soil, with the same assurance as if they could penetrate into their nature and essence, " Clay-marl," say they, " has more power to " destroy acids and to produce salts, than stone-
" marl : *ergo*, a less quantity of it upon land is
" sufficient. Marl extracts grease out of woollen
" cloth : grease is a species of oil : *ergo*, marl
" extracts oil from the air. A greater quantity
" of marl is laid on land, than of lime : *ergo*, it
" must have a greater effect in attracting vege-
" table food from the air. Shell-marl found un-
" der moss, is compounded of earth and the al-
" kaline salt of rotten wood. Because clay is
" mixed with sand in making brick, that mixture
" must be an enemy to vegetation. The mixing
" earth and lime with dung, makes an excellent
" compost. Rain makes flinty sand firmer and
" more compact," &c. &c. Some of these pro-
positions are erroneous, some at best doubtful.
And

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And yet, they are but a few of many propositions, boldly asserted by writers, though they would require the elucidation of a Newton or a Boyle. So much I will vouch for myself, that I have not mentioned a single article as certain, but what I have practised many years with success: the instructions contained in this book, are founded on repeated experiments and diligent observation. If any particular happen to be mentioned that has not come under my inspection, the reader is warned of it. In short, it will soon be perceived, that this is not a bookseller's production.

The dawn of a manufacture, is irksomely slow in its progress to broad day. Indocility is difficult to be overcome: habitual indolence, still more. These obstructions vanish in a manufacturing country. A boy learns by sight his father's trade, even before he can ply his little hand about an instrument. He acquires activity by seeing others active: he comprehends not what it is to be idle. This observation is strongly exemplified in agriculture. Some years ago, farmers in Scotland were ignorant and indolent; nothing to be seen but weeds and trash, not a single field in order. People who never saw better husbandry, had no notion of any better. Skill in agriculture is

b

spreading

spreading gradually in Scotland ; and young people acquire some knowledge by sight, even before they think of practice. After such advance, may we not hope, that our progress will be rapid ; and that agriculture will soon be familiar among us, and as skilfully conducted as in England ? May this reflection animate our landed gentry ; and inflame them with a desire, to acquire riches to themselves, and lustre to their country !

There never was in Scotland a period, when good lessons in husbandry were more seasonable than at present. This country, growing in population, affords not corn sufficient for its inhabitants ; and yet waste land abounds, which some skill and much industry would fertilize. Is it not deplorable, that in the best-cultivated shires, large patches of land should produce nothing but broom and whins, not from barrenness but from indolence ? Can greater encouragement to industry be wished, than a ready market for every thing the soil produces ? how different from the condition of Scotland, not more than forty years ago ! Can a landholder be employed more profitably for his country, or more honourably as well as profitably for himself, than to rouse emulation
among

among his tenants, by kind treatment, by instruction, by example, and by premiums? Let him study the rules contained in this little work, all of them plain and adapted to practice. Let him convene his tenants once a-year to a hearty meal, and engage them to follow these rules. What if he should bestow on the deserving, a plough or harrows of the best construction? Land cannot be improved at a cheaper rate. It was by such means, that the late John Cockburn of Ormiston, promoted emulation and industry among his people. His patriotic zeal was rewarded: he lived to see his estate in a higher degree of cultivation, than even to this day is seen in any other part of Scotland. The same means were employed more extensively, by the late Earl of Findlater: the skill and perseverance of that nobleman, raised his tenants from a torpid state, to a surprising degree of activity; and few can now vie with them, either for industry or knowledge. Had other landlords been equally active, how flourishing would agriculture have been in Scotland? How great a change to our advantage would there have been in the commercial balance, had we been feeding our neighbours instead of being fed by them; had we been in the

course

course of receiving money for our corn, instead of receiving corn for our money ! The field is still open : let us join hearts and hands to redeem time wofully mispent. I say again, there never was in Scotland a period more favourable to agriculture than the present.

Agriculture is a very ancient art. It has been practised every where without intermission ; but with very little attention to principles. In studying the principles laid down by writers, I found myself in a sort of labyrinth, carried to and fro without any certain direction. After a long course of reading, where there was nothing but darkness and discrepance, I laid aside my books, took heart, and like Des Cartes commenced my inquiries with doubting of every thing. I resorted to the book of nature : I studied it with attention : and the second part of this work contains the result of my inquiries. It is far from my thoughts, to impose my opinions upon others : I pretend only to have reduced the theory of agriculture into a sort of system, more concise at least, and more consistent, than has been done by other writers. Many eyes are better than one ; and if my theory shall be found erroneous, the many that have erred will serve in some measure

sure

sure to keep me in countenance. I am not however afraid of any gross error. An *imprimatur* from one of the ablest chemists of the present age, has given me some confidence of being in the right track *.

I have all along studied brevity, as far as consistent with perspicuity; and therefore, have confined myself to matters that I know to be of real use in practice. I am ambitious to have my plan followed, because successful experience has proved it to be solid; but I should not hope for many readers, if I hazarded the tiring them with unnecessary matters. Varro *de re rustica*, appears to be very sparing of instruction; but rivals Aristotle himself in the subtilty of his divisions. “Nunc
“dicam agri quibus rebus colantur. Quas res
“alii dividunt in duas partes, in homines et admi-
“nicula hominum: sine quibus rebus colere non
“possunt. Alii in tres partes, instrumenti genus
“vocale, et semivocale, et mutum. Vocale, in
“quo sunt servi; semivocale, in quo sunt ho-
“ves: mutum, in quo sunt plaustra.” Such puerile divisions, may be of use to swell a volume; but give no instruction, and are extremely tiresome.

* Dr Black professor of chemistry in the college of Edinburgh.

I cannot finish this preface without warmly recommending agriculture to gentlemen of land-estates ; for whose use chiefly this work is intended. In every well-governed state, agriculture has been duly honoured. In ancient Persia, a festival was yearly celebrated, in which husbandmen were freely admitted to the King's table. " From your labours, said the King, we receive " our sustenance ; and by us you are protected. " Being mutually necessary to each other, let us, " like brethren, live together in amity." The great emperor of China, performs yearly the ceremony of holding the plough, to show that no man is above being a farmer. The island Miletus, during many years, had been afflicted with factions : the government was settled by some wise men of Paros, a neighbouring island. These men having surveyed the island, and marked the possessor of every well-cultivated farm, convoked an assembly of the people, and appointed these persons to be governors. " The person," said they, " who governs his private affairs with prudence and industry, is qualified " to govern those of the public." The king of Tunis, invaded by a powerful enemy, promised to a neighbour who assisted him, the philosopher's

pher's stone. He sent a plough; terming it the philosopher's stone, because it would produce rich crops, to procure gold in plenty.

In the view of profit, agriculture is fit for every man. In the view of pleasure, it is of all occupations the best adapted to gentlemen in a private station. Matter crouds upon me, and I am at a loss where to begin. Agriculture corresponds to that degree of exercise, which is the best preservative of health. It requires no hurtful fatigue, on the one hand, nor indulges, on the other, indolence, still more hurtful. During a throng of work, the diligent farmer will sometimes be early and late in the field: but this is no hardship upon an active spirit. At other times, a gentleman who conducts his affairs properly, may have hours every day, to bestow on reading, on his family, on his friends.

Agriculture is equally salutary to the mind. In the management of a farm, constant attention is required to the soil, to the season, and to different operations. A gentleman thus occupied, becomes daily more active, and is daily gathering knowledge: as his mind is never suffered to languish, he is secure against the disease of low spirits.

But

But what I chiefly insist on is, that laying aside irregular appetites and ambitious views, agriculture is of all occupations the most consonant to our nature ; and the most productive of contentment, the sweetest sort of happiness. In the first place, it requires that moderate degree of exercise, which corresponds the most to the ordinary succession of our perceptions. Fox-hunting produces a succession too rapid : angling produces a succession too slow. Agriculture corresponds not only more to the ordinary succession, but has the following signal property, that a farmer can direct his operations, with that degree of quickness and variety, which is agreeable to his own train of perceptions. In the next place, to every occupation that can give a lasting relish, hope and fear are essential. A fowler has little enjoyment in his gun, who misses frequently ; and he loses all enjoyment, when every shot is death : a poacher, so dextrous, may have pleasure in the profit, but none in the art. The hopes and fears that attend agriculture, keep the mind always awake, and in an enlivening degree of agitation. Hope never approaches certainty so near, as to produce security ; nor is fear ever so great, as to create deep anxiety and distress. Hence it is, that a gentleman

gentleman farmer, tolerably skilful, never tires of his work ; but is as keen the last moment as the first. Can any other employment compare with farming in that respect ? In the third place, no other occupation rivals agriculture, in connecting private interest with that of the public. How pleasing to think, that every step a man makes for his own good, promotes that of his country ! Even where the balance happens to turn against the farmer, he has still the comfort that his country profits by him. Every gentleman farmer must of course be a patriot ; for patriotism, like other virtues, is improved and fortified by exercise. In fact, if there be any remaining patriotism in a nation, it is found among that class of men.

A gentleman farmer who is disposed to embellish his fields, has a great advantage over others. He can execute that pleasing work at the cheapest rate, by employing upon it his farm servants and cattle, every vacant hour. This slow method is indeed ill suited to the ardour of an Indian Nabob, impatient for enjoyment. But is not the advantage clearly on the side of the farmer ? The refined pleasure of embellishments, arises from a slow progress ; which affords leisure to feast the eye upon every new production.

In former times, hunting was the only business of a gentleman. The practice of blood made him rough and hard-hearted: he led the life of a dog, or of a savage; violently active in the field, supremely indolent at home. His train of ideas was confined to dogs, horses, hares, foxes: not a rational idea entered the train, not a spark of patriotism, nothing done for the public, his dependents enslaved and not fed, no husbandry, no embellishment, loathsome weeds round his dwelling, disorder and dirt within. Consider the present mode of living. How delightful the change, from the hunter to the farmer, from the destroyer of animals to the feeder of men! Our gentlemen who live in the country, have become active and industrious. They embellish their fields, improve their lands, and give bread to thousands. Every new day promotes health and spirits; and every new day brings variety of enjoyment. They are happy at home; and they wish happiness to all.

As the scene of my experience has all along been in Scotland, my native country, I am shy to recommend this plan of husbandry to any but to my countrymen. I have, however, a thorough conviction, that giving allowance for slight variations

variations of climate, the plan will suit England, France, Italy, and every other country situated within either of the temperate zones.

Among the old Romans there were excellent writers on husbandry; but I cannot prevail on myself to think that their practice was answerable. They were enslaved by observing superstitiously omens, prognostics, unlucky days, &c. which frequently prevented them from taking advantage even of the most favourable weather. They were conducted in a great measure by chance; and little scope was left for skill or foresight. Examples may be found in every one of their writers on husbandry. I shall confine myself to Columella the most celebrated of them. He gives the following receipt against the wevil from his own experience. "At the change of the moon, pull your beans before day-light; when perfectly dried before full moon, thresh them; and the seeds laid up in a granery, will suffer no damage from the wevil." He forbids vetches to be sowed before the twenty-fifth day of the moon; that otherwise they will be hurt by the snail. His way to prevent rats and mice from preying on a vineyard, is to prune the vines in the night-time when the moon is full.

full. The seed of medic, says he, ought to be covered with a wooden rake; for that iron is destructive to it. He orders frequent digging about a tree new planted; but discharges the ground to be touched with an iron tool after the planting. He quotes Aristotle as his authority, that among sheep the way to procreate a male is to admit the ram when the north wind blows; and to admit the ram when the south wind blows, in order to procreate a female. Tie up before copulation the left testicle, and the stallion will produce a male: tie up the right testicle, and he will produce a female. What does the reader think of the following prognostic? If a horse after covering a mare descend on the right hand, the foal will be a male: if on the left, it will be a female. It was believed by the Roman writers without a single exception, that mares in Lusitania were impregnated by the west wind. I congratulate my countrymen for their happy deliverance from such heavy fetters. There is now a fair field for exercising our talents, natural and acquired; and if we fail in any article, we have ourselves only to blame, not destiny.

In arts and sciences, a plentiful source of obscurity and indistinctness, is the using a word in
different

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different senses, without warning the reader of it. Considering what volumes have been composed on agriculture, it is amazing how little precision there is in the terms of art. Take the following instance. The word *furrow* is employed to signify not only the hollow made by the plough, but the earth taken out of that hollow, and also the hollow between ridges. Better coin words than write indistinctly. Let *furrow* be appropriated to the space in which the plough moves, and also to the hollow between ridges; which will not occasion any confusion. But I venture to distinguish the earth moved by the plough, by the name of the *furrow-slice*. The small hollows that appear between the slices when a ridge is plowed, may be termed *seams*.

Earth, land, ground, soil, are not synonymous; and therefore, in correct writing, their meaning ought to be ascertained. Earth is opposed to metals, fossils, and such like. Land is any indefinite section of this globe *a cælo ad centrum*. Ground is the surface of land; and every quality of a surface can be attributed to it, hilly ground, flat ground, smooth ground, rough ground, soft ground, hard ground. Quantity is an attribute of land, improperly of ground. We say current-
ly

ly a quantity of land, not a quantity of ground otherways than figuratively. The earth we tread on, with respect to its power of nourishing plants, is termed soil, rich soil, poor soil, dry soil, wet soil, clay soil, sandy soil. Staple is used by English writers with respect to the nature of the soil. In common language these terms are not distinctly separated; nor do I pretend that my definitions are altogether accurate. To fix a precise meaning to each will probably require a century or two more.

SCOTCH and ENGLISH Measures and Weights compared.

The measure of oats and barley is the same. The measure of wheat, pease, and beans, the same, both Linlithgow measure.

The wheat firloft of Scotland contains

of cubic inches - - - 2197 $\frac{34}{100}$

The barley firloft contains - - - 3205 $\frac{14}{100}$

The Winchester bushel of England - 2150 $\frac{42}{100}$

Therefore four firlots of barley are nearly equal to six firlots of wheat. And the Winchester bushel nearly equal to our wheat firloft.

The

P R E F A C E.

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The Scotch acre contains $55,353\frac{4}{10}$ square feet.

The English acre contains 43,360 square feet.

Therefore four Scots acres are little less than five English.

WEIGHTS.

The Troy ounce is - 480 Troy grains

The Averdupois ounce is , 437 $\frac{1}{2}$

The Scotch ounce is 476

100 pounds net Amsterdam weight is equal to
108 $\frac{1}{2}$ pounds Averdupois.

CON.

P. R. E. A. C. E.

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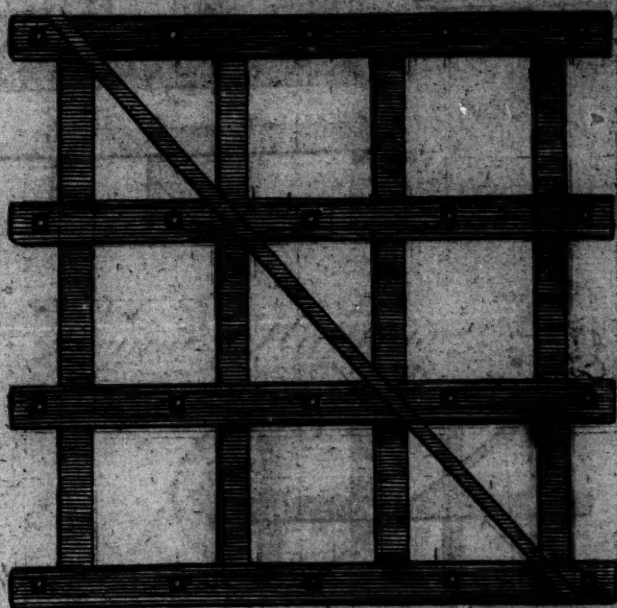
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Chain Plough

Plate 1



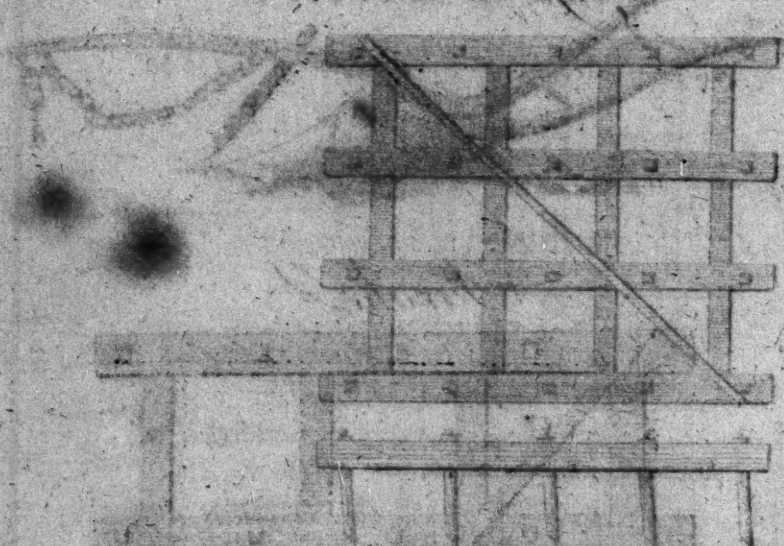
Brake



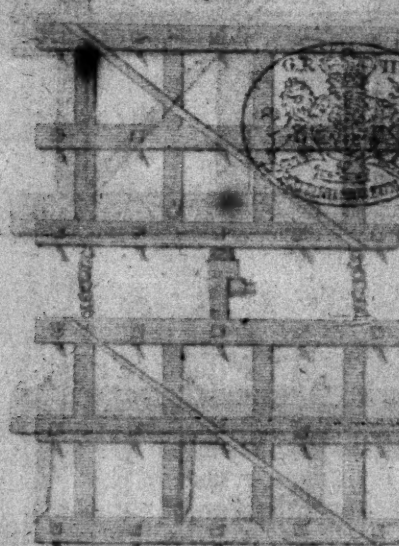
Models of the Instruments here delineated are ready for public inspection at the work yard of M Crichton Coachmaker Edin.

1793

James M. Harrison

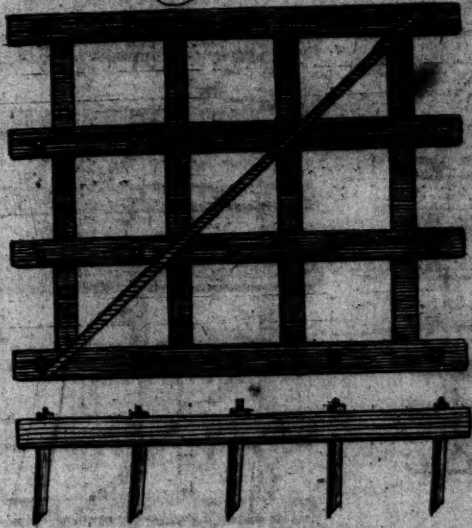


James M. Harrison

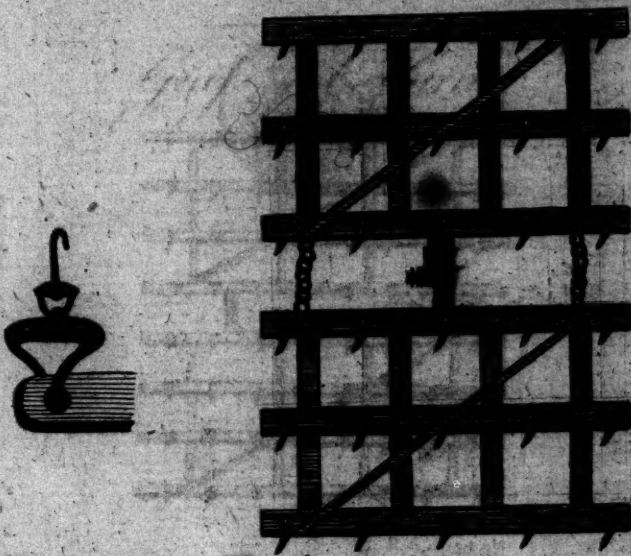


James M. Harrison

First Harrow



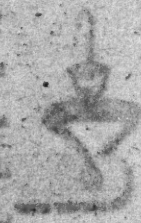
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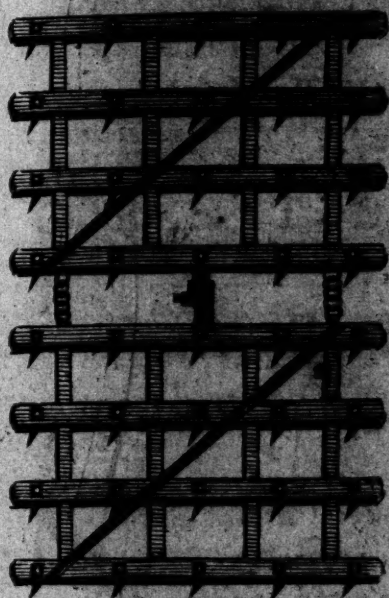
[Faint, illegible handwriting at the top of the page, possibly a title or header.]

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A table of numbers, similar to the ones above, with approximately 10 columns and 10 rows. A circular seal or stamp is placed in the center of the table. The seal features a royal coat of arms with a lion and a unicorn, and the text "BY APPOINTMENT TO HER MAJESTY" is visible around the border. Diagonal lines are drawn across the table from the top-left to the bottom-right.



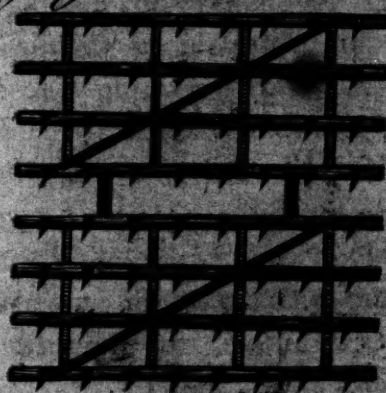
Third Harrow



Cleaning Harrow



Grass seed Harrow



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T H E
G E N T L E M A N
F A R M E R.

NATURAL HISTORY is confined to effects, leaving causes to Natural Philosophy. From a number of effects, Natural Philosophy ascends by induction to the immediate cause; and many of these causes are by another induction found to proceed from one more general and comprehensive. Such is the mode of reasoning in Natural Philosophy, till we arrive at an ultimate cause; that is, a cause beyond which we cannot penetrate. Most writers treat husbandry as a branch of Natural History. Some, more bold, consider it as also a branch of Natural Philosophy: they begin with effects, and endeavour to unfold the causes or principles. In addressing this treatise to Gentlemen, I attempt both. This suggests a division
A into

into two parts. In the first part, which indeed is the most useful, the best practice in every branch of husbandry is carefully explained. In the second, with timid steps and slow, I endeavour to trace out a few causes or principles that have an immediate influence upon practice.

PART

PART I.

PRACTICE of AGRICULTURE.

IT is unnecessary here to make a list of what is contained in this part. The particulars are in the prefixed table.

CHAPTER I.

INSTRUMENTS of HUSBANDRY.

IN the natural course of ideas, the hand goes before the instrument, and the instrument before the operation. But as the nature of man is a subject too important and too extensive to be ranged under any other head, I begin this treatise of agriculture with the instruments employed.

1. The PLOUGH.

THIS is the most useful instrument ever was invented. It is of more use than even the spinning-wheel: for men may make a shift for cloathing without that instrument, but a country cannot be populous without the plough.

The only plough used in Scotland, till of late, is a strong heavy instrument, about thirteen feet
from

from the handles to the extremity of the beam, and commonly above four feet from the back end of the head to the point of the sock. It is termed the *Scotch plough*, to distinguish it from other forms; and it needs no particular description, as it may be seen in every field. It may well be termed the *Scotch plough*; for of all forms it is the fittest for breaking up stiff and rough ground, especially where stones abound; and no less fit for strong clays hardened by drought. The length of its head gives it a firm hold of the ground: its weight prevents it from being thrown out by stones: the length of the handles gives the ploughman great command to direct its motion: and by the length of its head, and of its mould-board, it lays the furrow-slice cleverly over. The *Scotch plough* was contrived during the infancy of agriculture, and was well contrived: in the soils above described, it has not an equal.

But in tender soil it is improper, because it adds greatly to the expence of plowing, without any counterbalancing benefit. By the length of the head and mouldboard the friction is increased, requiring a greater number of oxen or horses than are necessary in a shorter plough. There is in its form, another particular that resists the draught: the mouldboard makes an angle with the sock, instead of making a line with it gently curving backward. An objection against it still more material, is, that it does not stir the
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the ground perfectly : the hinder part of the wrist rises a foot above the sole of the head ; and the earth that lies immediately below that hinder part, is not sufficiently turned over. This is ribbing land below the surface, similar to what is done by ignorant farmers on the surface.

These defects must be submitted to in a soil that requires a strong heavy plough ; but may be avoided in a cultivated soil by a plough differently constructed. Of all the ploughs fitted for a cultivated soil free of stones, I boldly recommend a plough introduced into Scotland about twelve years ago, by James Small in Blackadder Mount, Berwickshire ; which is now in great request ; and with great reason, as it avoids all the defects of the Scotch plough. The shortness of its head and of its mouldboard lessen the friction greatly : from the point of the sock to the back part of the head it is only thirty inches ; and the whole length, from the point of the beam to the end of the handles, between eight and nine feet. The sock and mouldboard make one line gently curving ; and consequently gather no earth. Instead of a wrist, the under edge of the mouldboard is in one plain with the sole of the head ; which makes a wide furrow, without leaving any part unstirred. It is termed the *chain-plough*, because it is drawn by an iron chain fixed to the back part of the beam immediately before the coulter. This has two advantages : first, by means
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of a muzzle, it makes the plough go deep or shallow; and next, it stresses the beam less than if fixed to the point, and therefore a slenderer beam is sufficient. These particulars will be better understood from inspecting the annexed figure.

This plough may well be considered as a capital improvement; not only by saving expence, but by making better work. It is proper for loams, for carse clays, and, in general, for every sort of tender soil free of stones. It is even proper for opening up pasture-ground that has formerly been well cultivated.

To finish an account of the plough, I must add a word about the sock. A spiked sock is used in the Scotch plough, and is essential in stony land. But a feathered sock ought always to be used in tender soil, free of stones: it cuts the earth in the furrow, and makes neat work. It is indispensable in ground where roots abound, as it cuts them below the surface, and prevents their growing. I esteem the feathered sock to be a valuable improvement. The industrious farmer would even borrow money to clear his ground of stones, in order to introduce it: in a twenty-years lease, the profit of it would repay the expence tenfold.

A wheel-plough possesses one advantage, that it requires no skill in the ploughman. But it requires more strength of cattle, the friction of the wheels being added to that of the ground. But

a much greater defect is, that the furrows must partake of the inequalities of the surface: every stone, every clod, disturbs its motion. To cross with a wheel-plough a field of high and narrow ridges, such as is fit for turnip, would ridge the furrows like the surface, and retain every drop of rain that falls on it. Therefore, I greatly prefer a plough without wheels, in expert hands.

Some ploughs are made with two small wheels running in the furrow, in order to take off the friction of the head; and this plough is recommended in a book, intitled, *The complete Farmer*. But all complicated ploughs are baubles; and this as much as any. The pivots of such wheels are always going wrong; and beside, they are choked so with earth, as to increase the friction instead of diminishing it.

If we look back thirty years, ploughs of different constructions did not enter even into a dream. The Scotch plough was universally used; and no other was known. There was no less ignorance as to the number of cattle necessary for this plough. In the south of Scotland, six oxen and two horses were universal; and in the north, ten oxen, sometimes twelve. The first attempt to lessen the number of oxen, was in Berwickshire. The low part of that county abounds with stone and clay marl, the most substantial of all manures, which had been long used by one

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or two gentlemen. About twenty-five years ago it acquired reputation, and spread rapidly. As two horses and two oxen were employed in every marl-cart; the farmer, in summer-fallowing and in preparing land for marl, was confined to four oxen and two horses. And as that manure afforded plenty of succulent straw for oxen, the farmer was surprised to find, that four oxen did better now than six formerly. Marling, however, a laborious work, proceeded slowly, till people were taught by a noted farmer in that country, what industry can perform by means of power properly applied. It was reckoned a mighty task to marl five or six acres in a year. That gentleman, by plenty of red clover for his working-cattle, accomplished the marling fifty acres in a summer, once fifty-four. Having so much occasion for oxen, he tried with success two oxen and two horses in a plough; and that practice became general in Berwickshire.

Now here appears with lustre the advantage of the chain-plough. The great friction occasioned in the Scotch plough by a long head, and by the angle it makes with the mouldboard, necessarily requires two oxen and two horses, whatever the soil be. The friction is so much less in the chain-plough, that two good horses are found sufficient in every soil that is proper for it. And as good luck seldom comes alone more than bad, the reducing the draught to a couple of horses
has

has another advantage, that of rendering a driver unnecessary; no slight saving at present, where a servant's wages and maintenance are very smart articles. This saving on every plough, where two horses and two oxen were formerly used, will by the strictest computation be fifteen pounds Sterling yearly; and where four horses were used, no less than twenty pounds Sterling. There is now scarce to be seen in the low country of Berwickshire a plough with more than two horses; which undoubtedly in time will become general. Had the practice of four horses in a plough continued, in vain would one have expected in this country a good breed of labouring horses, when four of our own paultry kind were more than sufficient: But, by better dressing, plowing became an easier work, and two horses in many soils were found sufficient. This discovery became gradually more general by lighter ploughs and stouter horses. There is now a demand for a better breed of labouring horses; which probably in time will perfect the breed. I know but of one further improvement, that of using two oxen instead of two horses. That draught has been employed with success in several places; and the saving is so great, that it must force its way every where. I boldly affirm, that no soil stirred in a proper season, can ever require more than two horses and two oxen in a plough, even supposing the stiffest clay. In all other

soils, two good horses or two good oxen, abreast, may be relied on for every operation of the chain-plough.

A chain-plough of a smaller size than ordinary, drawn by a single horse, is of all the most proper for horse-hoeing, supposing the land to be mellow, which it ought to be for that operation. It is sufficient for making furrows to receive the dung, for plowing the drills after dunging, and for hoeing the crop.

A still smaller plough of the same kind, I warmly recommend for a kitchen-garden. It can be reduced to the smallest size, by being made of iron; and where the land is properly dressed for a kitchen-garden, an iron plough drawn by a horse of the smallest size will save much spade-work. Strange is the effect of custom without thought! Thirty years ago, a kitchen-garden was an article of luxury merely, because at that time there could be no cheaper food than oat-meal. At present the farmer maintains his servants at double expence, as the price of oat-meal is doubled; and yet he has no notion of a kitchen-garden, more than he had thirty years ago. He never thinks, that living partly on cabbage, kail, turnip, carrot, would save much oat-meal: nor does he ever think, that change of food is more wholesome than vegetables alone, or oat-meal alone. I need not recommend potatoes, which in our late scanty crops
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of corn have proved a great blessing: without them the labouring poor would frequently have been reduced to a starving condition. Would the farmer but cultivate his kitchen-garden with as much industry as he bestows on his potato-crop, he needed never fear want; and he can cultivate it with the iron plough at a very small expence. It may be held by a boy of twelve or thirteen; and would be a proper education for a ploughman. But it is the landlord who ought to give a beginning to the improvement. A very small expence would enclose an acre for a kitchen-garden to each of his tenants; and it would excite their industry to bestow an iron plough on those who do best.

Nor is this the only case where a single-horse plough may be profitably employ'd. It is sufficient for seed-furrowing barley, where the land is light and well dressed. It may be used in the second or third plowing of fallow, to encourage annual weeds, which are destroy'd by subsequent plowings.

To procure food is indeed the chief object of the plough, but not its only object. Good roads are essential to internal commerce; and the expence of making them may be considerably lessened by the plough. As this hitherto has been little thought of, an explanation is necessary. The method in use is, to form a road with the pick-axe, the spade, and the wheelbarrow. Even
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where a pick-axe is not necessary, you see ten or twelve men pressing down the spade with the foot oftner than once before a sufficient load of earth can be raised; — dearly bought by the workmen, and still more dearly by the employer. Where a pick-axe is necessary, there must be a great addition of hands; for ten pickmen are no more than sufficient to loosen what can be thrown up with four or five spades. Now a great part of this labour may be saved by the plough. The Scotch plough, fortified with iron plates, and the head connected with the beam by a bar of iron, is an excellent instrument for making roads. Suppose a new road is purposed thirty feet wide, plough it up into a ridge, beginning in the middle; and plough it a second time in the same manner. Where the ground is soft, and requires to be raised high, a very deep furrow is necessary. Where the ground is firm, a shallow furrow is sufficient. After these two plowings are finished, if the sides of the road be too steep, leave six feet in the middle, and go round the remainder in a third plowing, gathering it toward the top. If the sides be still too steep, leave twelve feet in the middle, and gather up the remainder as in the former plowing. If these operations be well conducted, the water-channels on each side of the road will be two feet lower than the surface of the adjacent ground. Smooth the road with a drag-harrow; and correct with a spade any remaining

remaining defects or inequalities, which is a very easy work. Thus the road is completely formed to receive a covering of gravel, or of stones beat small.

A plough may also be used advantageously in making ditches for enclosing. The immense cost of loosening a hard or stony soil by the pick-axe and spade, may be totally saved by the plough. The surface-earth is commonly soft: after it is removed with the spade, let a plough, drawn by three horses in a line, go round and round the space intended for the ditch, cleaving it as if it were a ridge. After the earth thus loosened is thrown up with the shovel, renew the plowing and shovelling till you come within eight inches of the bottom; and to these eight inches apply the pick-axe and spade. One precaution is necessary, that no more be plowed at a time than can be thrown up the same day. If rain fall in any quantity, the ground tilled will become mud, very improper to be laid upon thorns. In this operation there is no occasion for the coulter: it is rather an impediment. I esteem this a valuable discovery for Scotland; which being more pestered with high winds than England, requires the more to be enclosed. The expence of enclosing with hedge and ditch the ordinary way, is great; and the ditch is the most expensive part. Two-thirds of the expence may be saved by the plough, in hard ground.

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In every case where earth is to be removed, the plough is useful; as for example in a gravel-pit opened for high-roads. The gravel may be so loosened by the plough as to require a shovel only for filling it into the carts.

Has any one stumbled on the thought of using the plough in planting young trees? The method I have practised, is to mark out lines due north and south, at intervals of ten or twelve feet. Let three deep furrows be made with the plough at the side of each line. Lay the sod of the east-most furrow upon the other two, which will raise a screen about two feet high. Plant along the furrow from whence the sod was removed, and the screen behind will make good shelter. This method is chiefly intended for firs in a bare moor. Before the firs rise much above the screen, the roots will have taken such hold of the ground as to resist even westerly winds: scarce a plant will fail, if they be wholesome. Three thousand firs planted in this manner may be sufficient for an acre, equal to five or six thousand in the ordinary way.

A fir makes a choice nurse for other trees. After three years, even in the poorest soil, the firs begin to grow with vigour; and then is the time for planting among them oaks, elms, or other trees; cutting down the firs from time to time to make room for these trees. Thus, the method here pointed out for planting firs, is the best preparation for raising all other barren trees.

2. The

2. The BRAKE, or DRAG-HARROW.

THE brake is a large and weighty harrow, the purpose of which is to reduce a stubborn soil, where an ordinary harrow makes little impression. It consists of square bulls*, four in number, each side five inches, and six feet and a half in length. The teeth are seventeen inches long, bending forward like a coulter. Four of them are inserted in each bull, fixed above with a screw-nut, having twelve inches free below, with a heel close to the under part of the bull, to prevent it from being pushed back by stones. The nut above makes it easy to be taken out for sharpening. This brake requires four horses or four oxen. One of a lesser size will not fully answer the purpose: one of a larger size will require six oxen; in which case the work may be performed at less expence with the plough. See the figure annexed.

This instrument may be applied to great advantage in the following circumstances. In following strong clay that requires frequent plowings, a brakeing between every plowing, tends to pulverize the soil, and to render the subsequent plowings more easy. In the month of March
or

* The wood of a brake, or of a harrow in which the teeth are inserted, is termed in Scotland a *bull*.

or April, when strong ground is plowed for barley, especially if bound with couch-grass, a cross-brakeing is preferable to a cross-plowing, and is done at half the expence. When ground is plowed from the state of nature, and after a competent time is cross-plowed, the brake is applied with great success immediately after, to reduce the whole to proper tilth.

Let it be observed, that a brake with a greater number of teeth than above mentioned, is improper for ground that is bound together with the roots of plants; which is always the case of ground new broken up from its natural state. The brake is soon choked, and can do no execution till freed from the earth it holds. A less number of teeth would be deficient in pulverizing the soil.

To set in a clear light the advantages of this instrument, we shall stop a little, to observe how insufficient the common harrow is for any of the operations mentioned. It may answer for covering the seed, and may do tolerably well in light and free soil; but is altogether insufficient for reducing stiff soil. The harrow with wooden teeth is a ridiculous instrument, fit to raise laughter instead of raising mould. The poor farmer labours with it, thinks he is doing an useful work, when all the time he is doing nothing. It ought to be prohibited by the landlord; for a tenant with such an instrument cannot pay a rent that
the

the farm properly cultivated will easily bear. Tho' the brake has been known above twenty years, yet none but gentlemen, and a few select tenants, have ever thought of it : in some countries even the name remains unknown. It belongs to gentlemen of fortune, for their own interest, to make it more general. The necessity of some instrument, more effectual than the common harrow, for reducing a stubborn soil, has led farmers to put three or four harrows, one above another, in order to press the undermost into the ground. This substitute to the brake is far inferior in its effect ; beside, that the undermost harrow is torn to pieces in an instant. To conclude this article, a farmer who has no brake, wants a capital instrument of husbandry. Its price above that of common harrows, bears no proportion to the profit.

3. The HARROW.

HARROWS are commonly considered as of no use but to cover the seed. They have another use scarce less essential, which is to prepare land for the seed. This is an article of importance for producing a good crop. And to shew how imperfectly either of these purposes is performed by the common harrow, take the following account of it.

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The harrow commonly used is of different forms. The first I shall mention has two bulls, four feet long and eighteen inches asunder, with four wooden teeth in each. A second has three bulls and twelve wooden teeth. A third has four bulls, and twenty teeth, of wood or iron, ten, eleven or twelve inches asunder. Now, in fine mould, the last may be sufficient for covering the seed; but none of them are sufficient to prepare for the seed any ground that requires subduing. The only tolerable form is that with iron teeth; and the bare description of its imperfections, will shew the necessity of a more perfect form. In the first place, this harrow is by far too light for ground new taken up from the state of nature, for clays hardened with spring-drought, or for other stubborn soils: it floats on the surface, and after frequent returns in the same track, does nothing effectually. In the next place, the teeth are too thick set, by which the harrow is apt to be choked, especially where the earth is bound with roots, which is commonly the case. At the same time, the lightness and number of teeth keep the harrow upon the surface, and prevent one of its capital purposes, that of dividing the soil. Nor will fewer teeth answer for covering the seed properly. In the third place, the teeth are too short for reducing a coarse soil to proper tilth; and yet it would be in vain to make them longer, because the harrow is too light for going deep.

deep into the ground. Further, the common harrows are so ill constructed, as to ride at every turn one upon another. Much time is lost in disengaging them. What pity it is, that an industrious farmer should be reduced to such an imperfect instrument, which is neither fit to prepare the ground for seed, nor to cover it properly. And I now add, that it is equally unfit for extirpating weeds. The ground is frequently so bound with couch-grass, as to make the furrow-slice stand upright, as when old lea is plowed: notwithstanding much labour, the grass-roots keep the field, and gain the victory. What follows? The farmer at last is reduced to the necessity of leaving the weeds in peaceable possession, because his field will no longer bear corn.

A little reflection, even without experience, will make it evident, that the same harrows, whatever be the form, can never answer all the different purposes of harrowing, nor can operate equally in all different soils, rough or smooth, firm or loose. Looking back not many years above thirty, no farmer in Scotland had the slightest notion of different ploughs for different purposes. The Scotch plough was the only one known. Different ploughs are now introduced; and it is full time to think of different harrows. Rejecting the common harrows, as in every respect insufficient, I boldly recommend the following. I use three of them of different forms, for
different

different purposes. They are all of the same weight, drawn each by two horses. Birch is the best wood for them, because it is cheap, and not apt to split. The first is composed of four bulls, each four feet ten inches long, three and a quarter inches broad, and three and a half deep; the interval between the bulls eleven and three fourths inches; so that the breadth of the whole harrow is four feet. The bulls are connected by four cross-bars, which go through each bull, and are fixed by wooden nails driven through both. In each bull five teeth are inserted, ten inches free under the bull, and ten inches asunder. They are of the same form with those of the brake, and inserted into the wood in the same manner. Each of these teeth is three pounds weight; and where the harrow is made of birch, the weight of the whole is six stone fourteen pounds Dutch. An erect bridle is fixed at a corner of the harrow, three inches high, with four notches for drawing higher or lower. To this bridle a double tree is fixed for two horses drawing abreast, as in a plough. And to strengthen the harrow, a flat rod of iron is nailed upon the harrow from corner to corner in the line of the draught.

The second harrow consists of two parts, connected together by a crank or hinge in the middle, and two chains of equal length, one at each end, which keep the two parts always parallel, and at the same distance from each other. The
crank

crank is so contrived, as to allow the two parts to ply to the ground like two unconnected harrows; but neither of them to rise above the other, more than if they were a single harrow without a joint. In a word, they may form an angle downward, but not upward. Thus they have the effect of two harrows in curved ground, and of one weighty harrow in a plain. This harrow is composed of six bulls, each four feet long, three inches broad, and three and a half deep. The interval between the bulls nine and a half inches; which makes the breadth of the whole harrow, including the length of the crank, to be five feet five inches. Each bull has five teeth, nine inches free under the wood, and ten inches asunder. The weight of each tooth is two pounds; the rest as in the former.

The third consists also of two parts, connected together like that last mentioned. It has eight bulls, each four feet long, two and a half inches broad, and three deep. The interval between the bulls is eight inches; and the breadth of the whole harrow, including the length of the crank, is six feet four inches. In each bull are inserted five teeth, seven inches free under the wood, and ten and a half inches asunder, each tooth weighing one pound. The rest as in the two former harrows. The figure of each is annexed.

These harrows I hold to be a considerable improvement. They ply to curved ground like two unconnected

unconnected harrows, and when drawn in one plain, they are in effect one harrow of double weight, which makes the teeth pierce deep into the ground. The imperfection of common harrows, mentioned above, will suggest the advantages of the set of harrows here recommended. The first is proper for harrowing land that has lain long after plowing, as where oats are sown on a winter-furrow; and in general, for harrowing stiff land: it pierces deep into the soil by its long teeth, and divides it minutely. The second is intended for covering the seed: its long teeth lays the seed deeper than the common harrow can do; which is no slight advantage. By placing the seed considerably under the surface, the young plants are protected from too much heat; and have sufficiency of moisture. At the same time, the seed is so well covered that none of it is lost. Seed slightly covered by the common harrows, wants moisture, and is burnt up by the sun; beside, that a proportion of it is left upon the surface uncovered. The third harrow supplies what may be deficient in the second, by smoothing the surface, and covering the seed more accurately. The three harrows make the ground finer and finer, as heckles do flax; or, to use a different comparison, the first harrow makes the bed, the second lays the seed in it, the third smooths the cloaths. These advantages are certain. If any man doubt, let him try the experiment, and he will

will find the effect of them in his crops. I can say so with assurance from the experience of many years. They have another advantage not inferior to any mentioned; they mix manure with the soil more intimately than can be done by common harrows; and upon such intimate mixture depends greatly the effect of manure, as shall be explained afterward. To conclude, these harrows are contrived to answer an established principle in agriculture, That fertility depends greatly on pulverizing the soil, and on an intimate mixture of manure with it, whether dung, lime, marl, or any other.

4. The ROLLER.

THE roller is an instrument of capital use in husbandry, though scarcely known in ordinary practice; and, where introduced, it is commonly so slight as to have very little effect.

Rollers are of different kinds, stone, yetling, wood. Each of these has its advantages. I recommend the last, constructed in the following manner. Take the body of a tree, six feet ten inches long, the larger the better, made as near a perfect cylinder as possible. Surround this cylinder with three rows of fillies, one row in the middle, and one at each end. Line these fillies with planks of wood equally long with the roller, and so narrow as to ply into a circle. Bind them
fast

fast together with iron rings. Beech wood is the best, being hard and tough. The roller thus mounted, ought to have a diameter of three feet ten inches. It has a double pair of shafts for two horses abreast. These are sufficient in level ground: in ground not level, four horses may be necessary. The roller without the shafts ought to weigh two hundred stone Dutch; and the large diameter makes this great weight easy to be drawn.

With respect to the season for rolling. Rolling wheat in the month of April, is an important article in loose soil; as the winter-rains, pressing down the soil, leave many roots in the air. Barley ought to be rolled immediately after the seed is sown; especially where grass-seeds are sown with it. The best time for rolling a gravelly soil, is as soon as the mould is so dry as to bear the roller without clinging to it. A clay soil ought neither to be tilled, harrowed, nor rolled, till the field be perfectly dry. And as rolling a clay soil is chiefly intended for smoothing the surface, a dry season may be patiently waited for, even till the crop be three inches high. There is the greater reason for this precaution, because much rain immediately after rolling is apt to cake the surface when drought follows. Oats in a light soil may be rolled immediately after the seed is sown, unless the ground be so wet as to cling to the roller. In a clay soil, delay rolling till the grain

grain be above ground. The proper time for sowing grass-seeds in an oat-field, is when the grain is three inches high; and rolling should immediately succeed whatever the soil be. Flax ought to be rolled immediately after sowing. This should never be neglected; for it makes the seed push equally, and prevents after-growth, the bad effect of which is visible in every step of the process for dressing flax. The first year's crop of sown grasses ought to be rolled as early the next spring as the ground will bear the horses. It fixes all the roots precisely as in the case of wheat. Rolling the second and third crops in loose soil, is an useful work; though not so essential as rolling the first crop.

The effects of rolling properly used, are substantial. In the first place, it renders a loose soil more compact and solid; which encourages the growth of plants, by making the earth clap close to every part of every root. Nor need we be afraid of rendering the soil too compact; for no roller that can be drawn by two or four horses will have that effect. In the next place, rolling keeps in the moisture, and hinders drought to penetrate. This effect is of great moment. In a dry season, it may make the difference of a good crop or no crop, especially where the soil is light. In the third place, the rolling grass-seeds, beside the foregoing advantages, facilitates the mowing for hay. And it is to be hoped, that the advantage

tage of this practice will lead farmers to mow their corn also, which will encrease the quantity of straw, both for food and for the dunghill.

There is a small roller for breaking clods in land intended for barley. The common way is, to break clods with a mallet, which requires many hands, and is a laborious work. This roller performs the work more effectually, and at much less expence: let a harrowing precede, which will break the clods a little; and after lying a day, or a day and half to dry, this roller will dissolve them into powder. This however does not supersede the use of the great roller after all the other articles are finished, in order to make the soil compact, and to keep out the summer-drought. A stone roller four feet long, and fifteen inches diameter, drawn by one horse, is sufficient to break clods that are easily dissolved by pressure. The use of this roller in preparing ground for barley is gaining ground daily, even among ordinary tenants, who have become sensible both of the expence and toil of using wooden mells. But in a clay soil, the clods are sometimes too firm, or too tough, to be subdued by so light a machine. In that case, a roller of the same size, but of a different construction, is necessary. It ought to be surrounded with circles of iron, six inches asunder, and seven inches deep; which will cut the most stubborn clods, and reduce them to powder. Let not this instrument be considered

ed as a final refinement. In a stiff clay, it may make the difference of a plentiful or scanty crop.

5. The FANNER.

THIS instrument for winnowing corn was introduced into Scotland not many years ago. Formerly wind being our only resource, the winnowing of corn was no less precarious than the grinding it at a windmill: people often were reduced to famine in the midst of plenty. There was another bad effect: it was necessary to place a barn open to the west wind, however irregular or inconvenient the situation might be with regard to the other buildings. But it is needless to be particular upon that useful instrument; because every farmer considers it now as no less essential than a plough or a harrow.

CHAPTER II.

FARM CATTLE and CARRIAGES.

I. FARM-HORSES.

A HORSE fit for a waggon, cart, or plough, ought to be strong, compact, and about fifteen hands high. A carter or a ploughman cannot perform the same work with horses of less size;

fize ; by which there is a considerable loss, as he is paid by the year, not by the quantity of work he performs. Great attention ought to be given to the breaking a farm-horse : good education will make him tractable and obedient to the voice, without necessity of applying the whip: the former makes the whole team move at once ; the latter moves the horse only that feels it.

We stop a little to consider the disadvantage of small and ill-fed horses, common in Scotland. Two stout horses in a plough will make as deep a furrow as four of what are commonly used ; and yet the former are less expensive both in price and maintenance. A gentleman cannot do better for his own interest, than to promote a good breed of farm-horses : two good horses will be a saving of L. 8 Sterling yearly, that is expended by using four weak horses. I shall mention only the carriage of lime. One servant fills his cart with a hundred stone, which two good horses can pull with ease. Another lays but the half upon his cart, because his two weak horses are able for no more. This is a double loss to the master ; he gets less work, not from the horses only, but also from the servant.

2. FARM-OXEN.

THERE is not in agriculture any other improvement that equals the using oxen instead of horses : they

they are equally tractable; and they are purchased and maintained at much less expence. As this improvement is obvious to the meanest capacity, one might expect to see every farmer greedily embracing it, as he would a feast after being famished. Yet few stir. How is this to be accounted for? Men are led in chains by custom; and fettered even against their interest. "And why should we pretend to be wiser than our fathers?" they will say modestly, or rather obstinately.

What warms me upon this subject, is the great consumption of oats by work-horses, which would be totally saved by using oxen only. Did our own product furnish this consumption, it were less to be regretted; but it is grievous to be reduced to the necessity of importing annually vast quantities of oats; all of which would be saved by employing oxen only in a farm. Nor is this all that would be saved, as shall be mentioned by and by.

But that I may not be accused of declaiming without foundation, I am willing to enter into a candid comparison between horses and oxen as employ'd in a farm. I begin with affirming, that an ox is as tractable as a horse, and as easily trained to a plough or a cart. I have seen a couple of them in a plough going as sweetly without a driver as a couple of horses; directed by the voice alone without a rein. Oxen beside are preferable

preferable for a steady draught, as they always pull to their strength, without ever finching: horses, on the contrary, are apt to stop when they meet with unexpected resistance. As oxen have less air and spirit in moving than horses, their motion is concluded to be slower. They are less expeditious, it is true, in galloping, or perhaps in trotting; but as farm-work is performed by stepping, let the step of a horse and of an ox be compared, and the latter will be found not inferior, especially where an ox is harnessed like a horse. Colonel Pool in Derbyshire plows as much ground with three oxen, as the neighbouring farmers do with four or five horses. In summer they eat nothing but grass: in winter, they have hay or turnip when much wrought; straw only when wrought moderately. About Bawtry, in Yorkshire, four oxen in a plough do as much work as the same number of good horses. In several parts of Kent, an acre daily is plowed with a team of oxen, sometimes a quarter more. Near Beaconsfield, Mr Burke plows an acre in a day with four oxen; and his neighbours do no more with four horses. In the road from Leeds to Wetherby, I saw a loaded cart drawn by two stout horses and a bull, all in a line, the bull in the middle. That draught was not slower than those before and after in the same road. And surely the bull would not have been added had he retarded the horses.

Hitherto

Hitherto the comparison holds pretty equal. In one article oxen are clearly preferable. Their dung makes excellent manure; and by that means they always improve the pasture. Horse-dung, on the contrary, burns where it falls, and hurts the pasture. Horse-dung from the stable has a greater tendency to burn than to rot; and to make it useful, it requires to be carefully mixed with cooler materials.

But the chief advantage of oxen comes under the article of savings, which branch out into many particulars. In the first place, the price of a horse fit for labour doubles that of an ox. An ox worth seven pounds, will perform as much solid work as a horse worth fourteen. This is an important article: the labouring cattle are the most expensive part of a farm-stock; and it is that expence which keeps back from farming many men whose skill and industry would afford them a comfortable living. In that view, it is greatly the interest of landlords to promote oxen, as they tend to multiply candidates for a farm; which not only gives the landlord opportunity for a proper choice, but raises every farm to its just value.

As an ox is cheaper than a horse, so he is fed cheaper in proportion. He requires no corn, and he works to perfection upon cut grass in summer, and upon hay in winter. He does well even upon oat-straw. Thus by using oxen, a farmer

mer can make money of his whole crop of oats, except what is necessary for maintenance of his family. The bulk of that product, on the contrary, is consumed by farm-horses. Even in the carle of Gowry, the consumption of oats on farm-horses is so great, that at Perth and Dundee, there are annually imported between four and five thousand bolls of oat-meal.

A horse is liable to many diseases that an ox is free from. If he happen to turn lame, to which he is subjected from many accidents, he is rendered useless. An ox may always be turned to account; for if disabled from work, he can be fattened for the shambles, and sold for more than was paid for him.

A horse commonly turns useless for work in ten years, and the stock of horses must be renewed every ten years at a medium, which is a deep article of expence to the farmer. Oxen last for ever; or, which comes to the same, they can be sold to the butcher when past the vigour of work, and their price will be more than sufficient to put young oxen in their stead.

Horses require more attendance than oxen: they must be curried, combed, and rubbed down. Let oxen have their proper quantity of food, and they require no other care. It is sufficient employment for a man to manage four or five horses: he will manage with equal ease double the number of oxen.

The

The shoeing of horses is no inconsiderable article. The expence of shoeing oxen is a mere trifle.

These several articles of saving are summed up in a following table, and are very considerable. This sum ought to go wholly to the landlord as additional rent. The tenant has no claim for any share; because after paying that additional rent, he has as much profit as he had formerly when he wrought with horses.

By this mode of husbandry, the advantage to the landlord is great; and to the kingdom much greater, by saving the importation of an immense quantity of oats. But the advantage of oxen is still more extensive: it reaches every manufacturer, and indeed the whole people. There must be a great increase of oxen to answer the purposes of farming: every one of these, after their prime is over, goes to the shambles: the markets are filled with beef, which not only lowers the price of beef, but of leather and tallow. The savings upon these articles would bring down the wages of our manufacturers, and consequently the price of our manufactures in a foreign market; not to mention that cheap manufactures at home tend also to lower wages.

People differ in the manner of yoking oxen. In some places they are yoked by the tip of the horn; in some by the root. These modes are visibly inconvenient. When an ox draws by the

E shoulder

shoulder like a horse, his head is free, and his motion natural. When yoked by the horns, he lowers his head to the line of the draught: his posture is constrained, and his step short. His neck indeed is strong, but his shoulder is a better *fulcrum* for the draught. To yoke an ox by the shoulder, his harness ought to be the same with that of a horse. The only difference is, that as his horns hinder the collar from being slipped over his head, it must be open below, and buckled after it is on. The advantage of yoking an ox by the shoulder was known even in the time of Columella; who says that fastening the yoke to their horns, is rejected by almost all who have written directions for husbandmen; for the cattle can exert greater efforts with the breast than with the horns. Book 2. chap. 2.

When the advantages of oxen for draught are so great, it cannot but appear strange, that in Britain oxen have almost totally been laid aside. Among the ancients, we read of no beasts for draught but oxen. It was so in Greece, as early as the days of Hesiod; and it was so every where. The Dutch at the Cape of Good Hope plow with oxen, and exercise them early to a quick pace, so as to equal horses in the waggon, as well as in the plough. They are used in the East Indies for carrying burdens; and they are fitter even than horses for that service, the back of an ox being convex, and consequently more able to support

support a weight than that of a horse. All that is necessary in the furniture for the back, is a bit of wood or stiff leather, to prevent the load from falling down upon the neck. The only cause I can assign for preferring horses, are bad roads, which were universal in Britain till lately. Being impracticable for carts during winter, the farmer carried his corn to market on horseback. A proper furniture for the back of an ox was not thought of, though an easy invention. And horses being thought necessary for carrying burdens, they were employed instead of oxen in every work: if employed at all, they are too expensive ever to be suffered to be idle. Another circumstance contributed. Because oxen require no corn, it is commonly imagined that they scarce require any food. They are put off during winter with dry straw, which after the turn of the year affords very little nourishment. They become too weak for working; and yet, instead of bettering their food, it is vainly thought that multiplying their number will answer; and thus may be seen in several places yoked in a plough, ten or twelve weak animals that can scarce support their own weight. We are now provided with good roads every where; and there is no longer the pretext of bad roads for preferring horses. Corn is now carried to market in carts, for which oxen are no less proper than horses. And it is hoped, that farmers will at last break through

through a bad custom, and open their eyes to their own interest. Nothing is more deeply their interest than to lay aside horses totally in farm-operations, and to employ oxen. The tacksmen profits first; but does not the landlord gain more, by enabling his tenants in new leases to pay a higher rent? Why then should gentlemen loitre, while they can so easily advance their rent without oppressing their tenants? Why do they not encourage their tenants by example and precept, to follow a mode that is equally beneficial to themselves and to their country? It will be hard indeed, if a single tenant cannot be found to see his interest: if a landlord can prevail but upon one or two of his tenants to take the lead, the rest will naturally follow. At any rate, he can force them to their own good, by prohibiting horses in every new lease. It is a strange sort of ambition that moves gentlemen to spend their estates in the House of Commons, where most of them are mere mutes, instead of serving their country and themselves at home, which is genuine patriotism *.

As

* Columella, Book 2. chap. 2, advises the ploughman to give his oxen a little rest at the end of every ridge. "But, says he, a longer ridge than one hundred and twenty feet is hurtful to the cattle, by fatiguing them more than they ought to be." Oxen are more fatigued with heat than horses; which appears even in this cold country

As computation is the touchstone of profit and loss, two computations are subjoined; one to satisfy the farmer of the sum he will save by employing oxen instead of horses; and one to shew what benefit will accrue to the public by the change. To set the first computation in a clear light, and to avoid fractions, I make the supposition, that a horse put to work at the age of five may endure hard work for twelve years, which is a large allowance beyond the truth. An ox is put to work at the age of four, and at seven is in his prime, which is the proper time to feed for the shambles. The computation accordingly is framed upon a revolution of twelve years; during which period oxen are four times changed without any change of horses. At the end of the period, both must be changed; and a new revolution goes on as before.

TABLE

country during the heat of summer. Yet in the hottest countries oxen are preferred for labour; how much more in a cold country like Scotland. A yoke of oxen among the old Romans commonly plowed a *jugerum* in a day, which is nearly equal to two-thirds of an English acre; two English acres making about three *jugera*. Our Saxon ancestors had their *bovata terra* or "ox gang," which was fifteen acres; six of which made a plough-land, *viz.* as much as six oxen can plow in a year.

*T A B L E, shewing how much a farmer saves by
employing Oxen instead of Horses.*

	L.	s.	d.	L.	s.	d.
A Horse of 5 years old is purchased or valued at				15	0	0
To grasing ditto 24 weeks, at 2 s. 1 d. per week	2	10	0			
To corn in winter 15 weeks, 2 pecks per week, at 8 d. per peck	-	1	0			
To corn in spring 13 weeks, 4 pecks per week, at 10 d. per peck	-	2	3			
To shoeing and farrying one year	-	0	12			
To insurance against lameness and death	-	0	7			
One year's maintenance	6	13	4			
Twelve years maintenance				80	0	0
Total amount of the first cost, and 12 years maintenance	-	-		95	0	0
The horse unfit for hard labour may be sold for	-	-		3	0	0
The expence of one horse at the end of twelve years	-	-		92	0	0

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The expence of an Ox twelve years.

	L.	s.	d.	L.	s.	d.
An Ox * 4 years old purcha- fed at	-	-	-	5	10	0
To graſing 24 weeks at 1s. 6 d. per week	-	1	16	0		
To ſhoeing and farrying one year	-	0	4	6		
To inſurance againſt acci- dental death	-	0	2	6		
Amount of one year's main- tenance	-	2	3	0		
Maintenance for 3 years				6	9	0
Coſt and maintenance	-			11	19	0
Deduce the price he can be ſold at				7	10	0
Total coſt at the end of 3 years	-			4	9	0
Total coſt at the end of 12 years	-			17	16	0
Subtract this ſum from the expence of a horſe during the ſame time,				92	0	0
The balance againſt the horſe is				74	4	0

By

* An ox light made and of a middle ſize, is of all the
fiteſt for the plough; and, in many places of Scotland,
ſuch

By this table it appears, that the yearly expence of a farm-horse exceeds that of an ox in the sum of L. 6 : 3 : 8. Now supposing four horses necessary to a farm of 100 acres, rent L. 50 yearly, four good oxen well fed will perform the same work ; and therefore the using the latter instead of the former, will be an annual saving of L. 24 : 14 : 8, very near the half of the rent. And what will raise it above half of the rent, is the interest of the money laid out, which is considerably higher upon the horse than upon the ox ; but which is omitted in the foregoing table, to avoid an intricate calculation.

There is beside an article that preponderates greatly for the ox. His dung enriches the ground on which he pastures. Horse-dung, on the contrary, is hurtful. This is an article of great importance.

N. B. The hay or straw consumed by the horse in winter is not less than that consumed by the ox ; and therefore that article is left out with respect to both.

Computation

such an ox may be purchased under six pounds. But an ox reared in a rich soil and that gets plenty of food, will at the same age draw a much higher price ; and, accordingly, computing the profit of rearing horned cattle, I have stated the value at seven pounds.

Computation of the yearly quantity of oats consumed in Scotland by labouring horses.

FOR repairing the highways in East Lothian, each farm that is managed with a single plough is rated at a certain sum; and there are in the county computed to be 1331 such farms. In every plough four horses are employed; and many farmers employ additional horses for harrowing, &c.; but supposing only four, the number of farm-horses will be 5324. According to the preceding table, the yearly quantity of corn consumed by a horse is 5 bolls 2 pecks; consequently the amount of the corn consumed annually is 27,285½ bolls; which, computed at 12s. a-boll, a moderate price, amounts to the sum of L. 16,371, 6s. Sterling.

Reckoning the horses employed in all the other corn-countries in Scotland, their number will be at least fifteen times as many as what are employed in East Lothian. Therefore, to find out the value of the oats consumed yearly in Scotland by work-horses, multiply the said sum of L. 16,371, 6s. Sterling by 16, which is L. 261,940, 16s.; an immense sum that would be saved to this nation by employing oxen in agriculture instead of horses. In one of Young's tours there are computed to be in England 684,491 draught cattle, of which the horses must amount at least to

F 680,000;

680,000; each of which may be reckoned to consume six bolls of oats yearly. And reckoning a boll of oats at twelve shillings, the value of oats consumed will amount to L. 2,448,000; all of which may be saved by employing oxen.

If I cannot prevail upon farmers to mind their own interest by employing oxen instead of horses, I shall at least make them blush, by comparing them with farmers no less obstinate in another particular. A farmer was brought from Northfolk to the neighbourhood of Axminster, who being disgusted at the husbandry practised there, commenced a better plan. His first attempt was, to make turnip a regular crop in rotation, and to hoe them twice in the Norfolk manner. He met with many obstructions from perverseness and awkwardness in his servants; but by perseverance, and working with them himself, he has prevailed. He now for many years has had exceeding good crops; which at the same time have improved the succeeding crops of barley. Of these facts his neighbours have been witnesses near twenty years; and yet not one of them has followed his example. Can there be a stronger instance of prejudice, or rather stupidity?

3. BREEDING HORSES and HORNED CATTLE.

In good husbandry, the greatest profit that can be made of grass is the breeding horses for sale,
The

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The profit will appear from the following table.

The stallion,	L. 0 15 0
Summer-grafs for the mare and foal,	2 0 0
Expence of the foal the first winter,	1 15 0
Summer-grafs second year,	- 1 5 0
Winter-grafs,	- 0 15 0
Summer-grafs third year,	- 1 10 0
Winter-grafs,	- 0 15 0
Summer-grafs fourth year,	- 1 15 0
Winter-grafs with corn,	- 1 10 0
Total expence,	L. 12 0 0
Being now rising five years old, his value,	- 16 0 0
Clear profit,	L. 4 0 0

A young horse after the first winter need not be housed till the fourth winter, provided he have a shed to fly into in a storm, with a little hay or straw.

It is still more profitable to buy young horses three years old, and at five to dispose of them, or work them in the farm.

A horse is a great eater. In common outfield-grafs it will take two acres for his summer-pasture. And even where ground has been laid out with grafs-seeds, it will take an acre and a half after the sixth or seventh year.

The breeding of horned cattle is also profitable,
and

and has a peculiar advantage, namely, that a beast bred on a farm, thrives always best there. The profit appears from the following table.

For the bull,	-	-	-	L. 0	2	6
For milk during summer,	-	-	-	1	0	0
For wintering,	-	-	-	0	10	0
Summer-grafs second year,	-	-	-	0	16	0
Winter-food,	-	-	-	0	10	0
Summer-grafs third year,	-	-	-	1	4	0
Winter-food,	-	-	-	0	15	0

Total expence, L. 4 17 6

A young bullock entering his fourth year, will sell for - - -

7 0 0

Clear profit, L. 2 2 6

4. WHEEL-CARRIAGES.

WHEEL-CARRIAGES for a farm are, waggons drawn by four horses; carts by one, two, or three horses; carts drawn by oxen in yokes, termed in Scotland *coups*; and a cart with three wheels by one horse. Till lately our farmers had no wheel-carriages; and to this day they are not universal.

Whatever strength a horse may have, yet the weight he can draw is determined by his own weight:

weight : in drawing, there is a certain weight that he cannot exceed without being raised off the ground ; and therefore, to enable him to exert his whole strength, some weight ought to be laid on his back. Nothing is more common than to see a carter mount the shaft-horse, when hard strained in drawing up-hill. He imagines that he has the horse more under command ; but the true reason is, that the horse draws more by having weight on his back. In the ordinary way of yoking two horses in a line, the shaft-horse, who is burdened with part of the weight of the cart, draws much more than the other horse can do.

I have taken some pains to know what can be drawn in a cart without straining the horses ; but I find no uniformity. Two horses in a cart, yoked in a line, usually draw, from Borrowstounness to Glasgow, three thousand weight. From Stirling to Glasgow they draw but twenty-four hundred weight. Alexander Monteith, a carter in the neighbourhood of Carron, has, with two horses, repeatedly drawn from Banton, in the parish of Kilfyth, to Carron, four thousand four hundred weight, each hundred weight consisting of one hundred and twenty pounds Avoirdupois. He commonly draws thirty-seven or thirty-eight hundred weight. The carts between Borrowstounness and Glasgow carry from ten to fifteen hundred weight with a single horse. And with the same

same draught they carry about Edinburgh twelve hundred weight of coals. They carried formerly no more but that weight with two horses yoked in a line. Mr Orr of Barrowfield, for carrying his coals to market, uses single-horse carts with wheels six feet high. Every cart carries easily twenty-one hundred weight to the place of unloading, which is distant from the coal-pit about two English miles; and this is done six times every day. The inequality of these weights shows the inaccuracy of carters, who have not come to any precise knowledge of what horses can perform in a cart. In the mean time, till more exact experiments be made, we shall take a middle rate, which is the three thousand weight drawn by two horses from Borrowstounness to Glasgow, the half of which for a single horse is fifteen hundred weight; though, considering the weight that lies upon the back of a single horse in a cart, his part of the draught may be well computed at sixteen hundred weight.

This leads to a comparison between a waggon and single-horse carts of the ordinary make. To keep within bounds, we may fairly take it for granted, that in a well constructed cart, a single horse of moderate size will command fourteen hundred weight; consequently that six horses in six carts will draw eight thousand four hundred weight. Let us now see what is drawn in a waggon with six horses. The ordinary weight in this

this country are four tons, or eight thousand weight; and I am informed it is the same about London. At that rate, six horses in six ordinary carts, draw four hundred weight more than six horses in a waggon. I suppose that the weight of the six carts will be at least equal to that of a waggon. At the same time, in a turnpike-road, a man and a boy are sufficient to manage the former as well as the latter.

But, to carry on the comparison, small carts have another advantage, which is, that they admit high wheels; and it is easy to adjust the wheels to the height of the horse, by making the axle go through the middle of the cart, or higher if necessary, to make the horse draw horizontally. It is a great ease to the horse to make the axle go through the centre of gravity; for by that means the weight on the horse's back is the same going up-hill or down-hill. A waggon carrying four or five tons, is incapable of that improvement; for high wheels able to support such a weight, would require a strength of timber that would be intolerable, especially in going up-hill. Here appears in a conspicuous light the advantage of single carts with high wheels above a waggon. Upon Mr Orr's practice, I take it for granted, that with wheels six feet high, a single horse will carry easily twenty-one hundred weight for a whole season. But let us state only two thousand weight, or a single ton, is not the conclusion fair, that in such
carts

carts six horses will draw a third more than in a waggon?

But to be more particular, two loaded carts with wheels as high as the hind wheels of a waggon, will be easier drawn by three horses in each, than the same load in a waggon with six horses. The advantage of the waggon is, that the shaft-horse has nothing to bear. On the other hand, the lateral shake from rough ground, so severe in the waggon, is divided between two horses in two carts. Here both have their advantages and disadvantages. To give the advantage of the waggon without the lateral shake, let six single-horse carts be used instead of a waggon, with the body below the axle and hung upon it so as to play freely. The disadvantage of twelve wheels instead of four, will be more than balanced by relieving the horses from the oppression of weight and from the lateral shake; and their strength will be intirely applied to pulling. At any rate, six single carts will draw more than is allowed to a waggon by the late act of parliament; which is no more but four ton beside the weight of the waggon.

Thus, single-horse carts are clearly preferable to a waggon with respect to the burden they can carry; and they are still more preferable with respect to the highways. A turnpike-road would be easily made, and more easily supported, were none but single-horse carts admitted, or were the toll

toll doubled or tripled upon waggon. This speculation merits the most serious attention of the legislature. To preserve turnpike-roads in perfect order, a single act of parliament would be sufficient. The Irish have taken the lead in this important article. We ought to follow without a moment's delay.

The proportion that ought to be laid on a horse's shoulders to have the greatest command of the draught, remains to be ascertained by experiments. But I guess, that a horse who can draw fourteen hundred weight without any load on his back, will with equal ease draw sixteen hundred, by laying on his back five or six stone of that weight.

A wheel-carriage is a great saving to the farmer, much greater than in a cursory view will be imagined. A cart with two horses carries five bolls of shell-lime wheat-measure. I talk of ordinary carts with two horses in a line; for two horses abreast in shafts will carry much more. Six horses commonly are used for carrying the same quantity on their backs. To the former one man is sufficient; to the latter, one to every two horses. Now, supposing a man and a cart with two horses, to be hired for three shillings a-day, the expence of the lime on horseback is nine shillings; in a cart, no more but three. Here is a saving of six shillings upon every five bolls. And supposing forty-eight cart-loads of lime to

be led in a summer, which is a moderate computation even in a farm that employs but a single plough, the saving amounts to L. 14, 8s. which alone is sufficient to convert a losing farm into a profitable one. I have been a witness to the carrying on horseback 700 loads of coals, a man to every two horses; the expence of which amounts to L. 52, 10s. supposing a man to be hired at eight pence a-day, and a horse at fourteen pence. That quantity can be carried in carts with two horses for L. 21 : 2 : 11. The same calculation is applicable to grain. A cart with two horses will carry to market six bolls of barley, which, when carried on horseback, require six horses. A single plough in tolerable soil well cultivated, will afford for sale a hundred bolls of grain, which carried in carts makes a saving of L. 4 Sterling.

The use of a three-wheeled cart drawn by a single horse, is to remove earth, or to carry manure to a near field. One horse serves two of these carts: when he returns after unloading, the other is ready filled. But this work is so severe for a single horse, that the field ought to be smooth and level; or inclining downward, which is still better.

I shall only add upon this head, that the sacks commonly used in Scotland for corn, are too large. In England small sacks are used, which one man can easily load or unload.

C H A P. III.

FARM-OFFICES.

IN this country there are few traces of skill or contrivance in farm-houses; no regard to a centric situation, nor to a dry spot, nor to ventilation. Our farm-offices are set down straggling and confused as if by accident; here a barn, there a stable. Imperfection in form is more excusable, there being few good examples to copy from: every where cow-houses so awkwardly formed, that they cannot be cleaned till the cattle be turned to the door; and so strait that they must dung upon each other. And lastly, after all the labours of the year, no place contrived for keeping corns dry.

Though to a stack-yard dryness of situation and free ventilation are essential; yet so little are these circumstances regarded, that it is always adjacent to the dwelling-house, whether the spot be wet or dry. It is at the same time carefully surrounded with trees, as if to prevent ventilation, and as if water dropping from the branches on the stacks were salutary to them.

A kitchen-garden is of importance to a farm, as will appear afterward. There is indeed always the name of a kitchen-garden, but very little of the reality. The chief attention is to surround

surround it with trees ; and yet the necessary effect of excluding free air, is to dwarf the plants, and to give them a bad taste.

It seems to be the opinion of our farmers, that a dunghill cannot be too moist ; for it is commonly put in a hole, and consequently surrounded with water : the richest parts are imbibed by the water, and both evaporate together, leaving the dunghill little better than a *caput mortuum*. Water at the same time, above a very moderate proportion, is far from contributing to putrefaction. I have seen a sheaf of straw, after lying six months in water, so tough as to be fit for making ropes.

The foregoing defects are but imperfectly remedied in the latest constructions. The form most in request is three sides of a square ; the houses for the farm-cattle on the east, the barn on the west, and sheds on the north, the dunghill occupying the middle of the square. The stables are too far from the barn ; the dung lies scattered, and trodden upon by the cattle ; and the expence of roofing is great.

These particulars are mentioned as an introduction to the following plan ; preferable upon two accounts ; first, as less expensive ; and next, as more convenient. The plan is, to erect a house of two stories, the under story for a stable, and the upper for a barn. The door of the stable fronts the east ; that of the barn the west, having

a stair that leads up to it. The stack-yard joins the barn, with free air to the north, west, and south. Round this building are sheds for cattle laid to the walls, with roofs sloping from the eaving. The sheds should be twelve feet wide, sufficient for the size of any farm-beast; and the outward wall may be seven feet high or so. There is place for six sheds, one on each gable, and two on each side-wall, leaving an interval for the doors of the barn and stable.

There will be found a great saving in this plan, compared with the other mentioned. To form a just comparison, they ought to be equally capacious; the two barns ought to be of the same size, and there ought to be room for the same number of cattle. The expence of each is annexed; and the saving on the plan recommended is no less than L. 94 : 2 : 2 Sterling. This is an important article to every gentleman who possesses an estate in a corn-country; for no article is heavier than the building farm-houses. Next as to convenience. In the ordinary form, where the barn is on the one side of a court, and the stables on the opposite side, the time consumed in carrying straw to the cattle is almost entirely saved in the plan proposed; there being holes in the barn-floor over every stall, covered with a moveable board, through which straw is let down to the cattle; which abridges greatly the labour of the ploughman and carter. At the same

same time, to leave such work to servants without any check, is often made a screen for idleness. With respect to threshing, a timber-floor has great elasticity; and I am made certain from experience, that a third part more may be threshed on it than on an earthen floor, which has no elasticity. Further, the frequent sweeping of an earthen-floor raises the finer parts of the earth, which mix with the grain: this is totally prevented in cleaning corn upon a timber-floor. Add that the dampness of an earthen floor corrupts the grain; it cannot be kept a fortnight from vegetating, especially if laid up to the damp wall. Sacks give no security; for they rot if allowed to stand in the barn any time. A barn in a second floor is excellent for preventing all these evils; one end contains a stack of corn, the middle is for threshing, and the other end for cleaning the corn when threshed. Above this end, there is a loft for holding the cleaned corn, to which there is easy access by a stair; and here corn may be kept in safety for months.

It will be objected against this plan, that there is no court for a dunghill, where winterers are commonly fed. But this I have purposely avoided; for it will be seen afterward, in the instructions given for the feeding of cattle, that to keep winterers in that manner is hurtful both to them and to the dunghill. They will be more comfortably put up in sheds; provided only in building

ing care be taken to give a free circulation of air.

One article still remains, in treating of farm-offices, which is a house for laying up instruments of husbandry, when not employed. Few farmers are sufficiently careful about this article : they behave as if instruments of husbandry could be procured without pains, and without price. It is true indeed, that these instruments are generally so mean and so insufficient as to deserve very little care ; — nothing more common, than to be left where last used, open to heat and cold, drought and moisture.

To form a just notion of the properest method for preserving wood, I must premise, that it will last equally well in air and in water ; but it must be kept constantly in the one or the other. What destroys wood is the alternate action of air and water. Observe a stake driven into the ground : the part that consumes first, is not that under the surface, nor that freely above it, but the ring at the surface, to which air and moisture have equal access. The same, where one piece of wood is mortised into another : the part that decays first, is where the two pieces join, which is open to the air, and at the same time lodges moisture. The same is observable in the putrefaction of a dunghill : the parts from which either air or water is excluded, never rot. Though in a mortise the parts joined rot the soonest, yet the mortised, part, from which both air and water are excluded

cluded, decays sooner than that which is open to the air, supposing it to be kept dry.

Hence it follows, that to preserve wood in the most perfect manner, it ought to be sheltered from rain, and exposed as much as possible to the ventilation of dry air. This suggests the best construction of a house for preserving instruments of husbandry. It ought to be erected in the highest spot, free to every wind: it ought to have a roof supported on pillars; the sides ought to be constructed like those of a drying-house at a bleach-field, with moveable boards for admitting air and excluding rain. Three feet or so may be left open at bottom; because so low down no rain can penetrate to do mischief. Need I add, that before laying up any instrument, it ought to be carefully cleaned and dried?

Expence of Farm-offices round a Farm-yard.

Building 18 roods 2 yards, at L. 1, 5s.

per rood,	-	-	-	L.	23	6	4
Logs, 1120 feet, at 12 d. per foot,	56	0	0				
Deals, 1148, at 12 d. per yard,	57	8	0				
Binding the roof and farking, at 2 d.							
per yard,	-	-	-	-	9	11	4
Slates, 52,000, at 16 s. per 1000,	41	12	0				
Nails, 86,000, at 5 s. per 1000,	-	21	10	0			
Slating 31 roods 32 yards, at 16 s. 8d.							
per rood,	-	-	-	-	26	0	10
8 doors, at 7 s. each,	-	-	-	-	2	16	0

L. 238 4 6

Ex-

Expence of the form recommended.

Building 13 roods 6 yards, at L. 1, 5s.			
per rood, - - -	L. 16	8	0
Logs, 615 feet, at 12 d. per foot,	30	15	0
Deals for sarking, 576 yards, at 12 d.			
per yard, - - -	28	16	0
Binding the roof, 2 d. per yard,	4	16	0
Slates, 32,400, at 16 s. per 1000, -	25	18	8
Nails, 43,000, at 5 s. per 1000 -	10	15	0
Slating 19 roods 4 yards, at 16 s. 8 d.			
per rood, - - -	16	13	0
Deals for flooring, 85, at 16 d. each,	6	1	8
Laying the floor, 88 yards, at 6 d.			
per yard, - - -	2	4	0
Doors 5, at 7 s. each, - - -	1	15	0
	L. 144	2	4

N. B. The expence of the house for holding the husbandry instruments, is not taken into this account; because every farm ought to be provided with such a house, whatever be the construction of the other farm-offices.

C H A P. IV.

PREPARING LAND for CROPPING.

I. OBSTRUCTIONS to CROPPING.

IN preparing land for cropping, the first thing that occurs to the writer and to the husbandman, is to consider the obstructions to regular plowing. The most formidable of these, are stones lying above or under the surface, which are an impediment to a plough, as rocks are to a ship. Did not custom account for it, how strange would it appear, that few proprietors or tenants in Scotland think of clearing their land of stones. Stones above the surface may be avoided by the ploughman, though not without loss of ground; but stones under the surface are commonly not discovered till the plough be shattered to pieces, and perhaps a day's work lost. The clearing land of stones is therefore necessary to prevent mischief. And to encourage the operation, it is attended with much actual profit. Take the following particulars. The stones are useful for fences: when large they must be blown, and commonly fall into parts proper for building. And as the blowing, when gunpowder is furnished, does not exceed a halfpenny for each inch that is bored, these stones come cheaper than to dig

dig as many out of the quarry. In the next place, as the soil round a large stone is commonly the best in the field, it is purchased at a low rate by taking out the stone. Nor is this a trifle; for not only is the ground lost that is occupied by a large stone, but also a considerable space round it, to which the plough has not access without danger. A third advantage is greater than all the rest; which is, that the plowing can be carried on with much expedition, when there is no apprehension of stones: in stony land, the plough must proceed so slowly, as not to perform half of its work.

To clear land of stones, is in many instances an undertaking too expensive for a tenant who has not a very long lease. As it is profitable both to him and to his landlord, it appears reasonable that the work should be divided, where the lease exceeds not nineteen years. It falls naturally upon the landlord to be at the expence of blowing the stones, and upon the tenant to carry them off the field.

It is vain to think of drawing any considerable rent, till a farm be cleared of stones. Why then do gentlemen neglect this means of improving their land? In a lease, let it be a proviso, that the landlord or his steward be advertised of every stone that obstructs the plough. When a number of these are marked, let an artist be employed to bore and to blow; and the landlord has
done

done his part. I engage that he will make twenty *per cent.* of the money laid out in this operation.

Another obstruction is wet ground. Water is a good servant, but a bad master. It may improve gravelly or sandy soils; but it sours a clay soil, and converts low ground into a morass, unfit for any purpose that can interest the husbandman.

A great deal has been written upon different methods of draining land, mostly so expensive as to be scarce fit for the landlord, not to mention the tenant.

One way of draining without expence when land is to be enclosed with hedge and ditch, is to direct the ditches so as to carry off the water. But this method is not always practicable, even where the divisions lie convenient for it. If the run of water be considerable, it will destroy the ditches, and lay open the fences, especially where the soil is loose or sandy.

If ditches will not answer, hollow drains are sometimes made, and sometimes open drains, which must be made so deep as to command the water. The former is filled up with loose stones, with brush-wood, or with any other porous matter that permits the water to pass. The latter is left open and not filled up. To make the former effectual, the ground must have such a slope as to give the water a brisk course. To execute them in level ground is a gross error; the passages are
soon

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soon stopped up with sand and sediment, and the work rendered useless. This inconvenience takes not place in open drains; but they are subject to other inconveniencies: They are always filling up, to make a yearly reparation necessary; and they obstruct both plowing and pasturing.

I venture to recommend the following drain as the best in all views. It is an open drain made with the plough, cleaving the space intended for the drain over and over, till the furrow be made of a sufficient depth for carrying off the water. The slope on either side may by repeated plowings be made so gentle as to give no obstruction either to the plough or to the harrow. There is no occasion for a spade, unless to smooth the sides of the drain, and to remove accidental obstructions in the bottom. The advantages of this drain are manifold. It is executed at much less expence than either of the former; and it is perpetual, as it never can be obstructed. In level ground, it is true, grass may grow at the bottom of the drain; but to clear off the grass once in four or five years, will restore it to its original perfection. A hollow drain may be proper between the spring-head and the main drain, where the distance is not great; but in every other case the drain recommended is the best.

Where a level field is infested with water from higher ground, the water ought to be intercepted by a ditch carried along the foot of the high

high ground, and terminating in some capital drain.

The only way to carry off water from a field that is hollow in the middle, is a drain still lower. This is commonly the case of a morass fed with water from higher ground, and kept on the surface by a clay bottom.

A clay soil of any thickness is never pestered with springs; but it is pestered with rain, which settles on the surface as in a cup. The only remedy is high narrow ridges, well rounded. And to clear the furrows, the furrow of the foot-ridge ought to be considerably lower, in order to carry off the water cleverly. It cannot be made too low, as nothing hurts clay soil more than stagnating water; witness the hollows at the ends of crooked ridges, which are absolutely barren. Some gravelly soils have a clay bottom, which is a substantial benefit to a field when in grass, as it retains moisture. But when in tillage, ridges are necessary to prevent rain from settling at the bottom; and this is the only case where a gravelly soil ought to be ridged.

Clay soils that have little or no level, have sometimes a gravelly bottom. For discharging the water, the only method I can think of, is, at the end of every ridge to pierce down to the gravel, which will absorb the water. But if the furrow of the foot-ridge be low enough to receive all the water, it will be more expeditious to make a
few

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few holes in that furrow. In some cases, a field may be drained, by filling up the hollows with earth taken from higher ground. But as this method is expensive, it will only be taken where no other method answers. Where a field happens to be partly wet, partly dry, there ought to be a separation by a middle ridge, if it can be done conveniently. And the dry part may be plowed, while the other is drying.

The low part of Berwickshire is generally a brick clay, extremely wet and poachy during winter. This in a good measure may be prevented by proper inclosing, as there is not a field but can be drained into lower ground, all the way down to the river Tweed. But as this would lessen the quantity of rain in a dry climate, such as is all the east side of Britain, it may admit of some doubt whether the remedy would not be as bad as the disease.

Broom and whins are great obstructions to cropping. Broom is an evergreen shrub that thrives best in sandy soil; and there it grows so vigorously, as scarce to admit any grass under it. A plant of broom that has arrived to its full size, dies when cut over: but this does not root out broom, because it grows from seed lodged in the ground; beside, that there can be no cropping while the stumps remain. An effectual way to root out this plant, is, after cutting the great stems close to the ground, to carry them off the field.

And

And the ground may be cleared of the roots, by a Scotch plough with a spiked sock, drawn by two oxen and two horses.

The field thus cleared may bear a crop of oats, or two; and with proper manure may be continued in tillage, or laid down with the seed of pasture-grasses. The latter is preferable from the nature of the soil, which is commonly sandy.

But as the seed of broom lies long in such soil without rotting, the farmer may reckon upon a plentiful crop from the seed along with the grass. To pull up the young broom with the hand, is an expensive work; and for a large field it is difficult to procure hands. Another method practised is, to cut the young broom with a sythe. But the broom comes up next year in double quantity; for it springs from young roots, tho' not from old.

Sheep, fond of broom, devour greedily every young shoot; and when they feed on it alone, it is apt to make them drunk; which appears from some of them tumbling over when heated by being driven beyond their ordinary pace. In a pasture-field, a few bushes make a shelter; and the cropping of sheep prevents them in a good measure from spreading. This suggests a method of rooting out the young broom that grows in pasture-ground, which is to pasture the field with sheep. If any escape the first year, there will not be left a vestige after the second. Beside the easiness of this method, it is profitable, as
there

there is no food more nourishing to sheep than young broom in moderation.

Where it is necessary or convenient to keep the field in corn, horse-hoeing is the only way to subdue broom. This sort of husbandry encourages every seed to vegetate; and the frequent plowings that are necessary to a drilled crop, destroy broom as well as other weeds. Some may escape the first year, but they cannot escape subsequent horse-hoeing.

A whin is a fine evergreen shrub, carrying a sweet smelling flower all the year, except in frost. But in husbandry, beauty is not regarded in opposition to profit. This shrub spreads wonderfully in poor soil; and when once established, it is not to be extirpated but by much labour. The roots of broom push downward; and for that reason, probably, broom springs not from the root. The roots of a whin, on the contrary, push horizontally, to the distance sometimes of ten or twelve feet. While the plant is growing, it draws the whole juices from the roots; but when cut down, these juices push up suckers from every root that lies near the surface. And hence the difficulty of extirpating whins.

The best method is, to set fire to the whins in a windy day during frost. Frost has the effect to wither whins, and to make them burn readily: the harder the frost, the better. Cut over the stumps with a hatchet, and wait till the ground

be softned with rain. At that time, a firm plough with a strong draught, will tear all the roots into shreds, which will be brought above ground by a heavy brake. The expence of this operation is small, compared with the common method of rooting out whins with a hoe ; and it is the less to be grudged, as being done in wet weather, when the plough cannot be otherwise employed. Oxen are the fittest for this operation ; because they make a steady draught, and do not, like horses, give up when they meet with unexpected resistance.

If the field be soon laid down in grass, whins will spring up in abundance, not only from seed, but from the small fibres that may have escaped the plough and brake. Pasturing with sheep is the only remedy : and it is an effectual remedy, if applied immediately after the whins spring ; for sheep are no less fond of whins than of broom ; and if there be a sufficient number, they will not leave a single plant above ground. Their springing for years need not be repined at ; for in their infant state they are excellent food, equal to any plant that grows. If this method be neglected till the whins have grown into wood, sheep come too late ; they will feed on the tender parts, but the bush continues healthy ; of which we have examples every where in open fields.

But if grass be not immediately wanted, horsehoeing husbandry is the most effectual method
for

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for clearing a field from whins. And when a field is once enriched by labour and manure, one need not be afraid of whins, as a poor soil is only proper for them.

Whins are a food so nourishing, not only to sheep but to horned cattle, that a poor soil cannot be better employed than in bearing crops of them: they are ate pleasantly in their infant-state, while the prickles are yet so tender as not to hurt the mouth.

Having touched the article of food, though foreign to the present chapter, I am excited to observe, that the tops of the oldest whins, cut off with a hedge-bill, make a hearty food for cattle when boiled. And to encrease the doze, thistles, every bulky weed, and the roots of cabbage; may be boiled with the whins. This I am informed is an ordinary practice in Germany.

Molehills may be justly considered as an obstruction to cropping. It is therefore beneficial to destroy moles; and the simplest way is, to lay hold of the young, which are always found in the large molehills. Buffon is uncertain whether they breed more than once a-year; but says, that young moles are found from April to August. What I found, were generally between the first of May new style and the first of May old style.

2. BRING-

2. BRINGING INTO CULTURE LAND from the STATE OF NATURE.

THE following method of improving a moor is contained in a letter addressed to me by an expert farmer. " I began with plowing as much of " the moor as I had a prospect of dung for. It " was cross-plowed next spring, and well harrowed. About Midsummer, it was plowed " again in the direction of the first plowing, and " well harrowed. It was plowed the fourth " time before winter, but not harrowed. It got " the fifth plowing in the succeeding April, at " which time the sward was well broken and rotted. It was dunged liberally; and after plowing the dung into the ground, I sowed turnip. " New ground, however poor originally, never " disappointed me of a rich crop of turnip the first " year, barley or oats the second, and clover and " rye-grass the third. And yet there are several " late instances of turnip failing in the best infield " grounds, among my neighbours and in my own " farm. In the year 1759, unwilling to trust the " whole of my turnip-crop to the moor, I prepared and dunged part of my best infield, and sowed it with turnip. Not a single drill appeared " from the first sowing; and but a scanty crop " from the third: in the moor not a single drill " failed. I was anxious to discover the cause:

" I

" I could not attribute the difference to soil or
 " situation, which were in favour of the infield ;
 " and the management was the same. The black
 " fly, it is true, had destroyed the infield crop ;
 " but I was puzzled why they had abstained from
 " the moor. Upon examining narrowly the two
 " fields, I discovered that the black flies in the
 " infield were young and very small, not able to
 " fly, but only to creep or hop about. Not a
 " single fly could be seen in the moor. This led
 " me to the following speculation. Nature has
 " taught the various tribes of flies and insects, to
 " deposit their eggs in places the best adapted for
 " the production and nourishment of their young.
 " Warm and rich grounds answer these purposes
 " the best : moor-grounds are cold and barren.
 " I reflected further, that when once these insects
 " chuse for their habitation a rich soil where there
 " is plenty of food, they deposit their eggs there ;
 " and the race is propagated from year to year.
 " A vacuity of ten or twelve yards in one of the
 " moor-drills seemed not to square with my theo-
 " ry. But upon enquiry I found, that a small
 " shower of rain had stopped the holes of the
 " drill-box a little time."

So far my correspondent. His method is good ;
 but it is laborious ; and the soil with three plow-
 ings may be rendered as proper for turnip, as
 with the six he gave it. The following altera-
 tion is what I propose. Let the moor be opened
 in

in winter when it is wet ; which has one convenience, that the plough cannot be employed at any other work. In spring, after frost is over, a slight harrowing will fill up the seams with mould, to keep out the air and rot the sod. In that state let it lie the following summer and winter, which will rot the sod more than if laid open to the air by plowing. Next April, let it be cross-plowed, braked, and harrowed, till it be sufficiently pulverized. Let the manure laid upon it, whether lime or dung, be intimately mixed with the soil by repeated harrowings. This will make a fine bed for the turnip-feed, if sown broad-cast. But if drills be intended, the method must be followed that is directed afterward in treating of the culture of turnip.

Repeated experience has convinced me, that turnip in moorish ground runs no risk from the black fly, nor probably in any ground newly broken up. It is an old observation of gardeners, that their plants thrive best in new ground ; for what other reason, than that they have no enemies to destroy them ? It must give pleasure to those who wish prosperity to their country, to be informed, that moorish grounds of a tolerable soil are fit for producing turnip ; a profitable crop of itself, and still more profitable by preparing the ground for subsequent crops. Considering the immense quantity of moor in Scotland, it must give pain to think how little progress is made in
its

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its cultivation. We see a fair example given near twenty years ago, neither expensive nor intricate. Why does not every farmer exert his utmost industry upon so valuable an improvement? Custom fetters men in chains. To break loose from slavery, a man must be blessed by nature with a superior degree of understanding and activity. Such men there are, though rare: their example will be imitated; and it is a pleasing prospect, that our barren moors will in time be converted into good soil, productive of nourishment for man and beast: villages will arise, and population go on in a rapid course. I present to the view of my reader an immense moor between Greenlaw in Berwickshire, and Fala in Mid Lothian, as a desirable subject for an improving farmer, now that there is access to lime by a turnpike-road. As the soil for the most part is too shallow for paring and burning, it may be cultivated according to the directions given above. At the same time, there are many swampy spots, which upon paring and burning will yield a great quantity of ashes, to be laid upon the dry parts; and these ashes make the very best manure for turnip. A successful turnip-crop, fed on the ground with sheep, is a fine preparation for laying down a field with grass-seeds. And it is a still greater improvement, to take two or three successive crops of turnip, which will require no dung for the second and following crops. This will thicken the soil,
and

and enrich it greatly. In that high country, where rain superabounds, the profitable crop is grass, not corn. And farms in that country, after being improved, ought to be divided into inclosures of fifty or sixty acres. Sheep require a hundred acres, to give them space for an extensive walk; and in such an inclosure any fence keeps them in *.

The best way of improving swampy ground after draining, is paring and burning. But where the ground is dry, and the soil too thin for paring, the best way of bringing it into tilth, is to plow it with a feathered sock, laying the grassy surface under. After the new surface is mellowed with frost, fill up all the seams by harrowing cross the field, which by excluding the air will effectually rot the sod. In this state let it lie summer and winter. In the beginning of May after, a cross plowing will reduce all to small square pieces, which must be pulverized with the brake, to make it ready for a May or June crop. If these square

* Scotland probably was mostly covered with trees before the commencement of agriculture; from which we ought to expect its surface to be generally vegetable soil. Yet most of it is barren earth, without any mixture of vegetable soil. Did such large tracts never carry trees? I can hardly think so, as trees are found growing in the most barren spots. Yet in America, which abounds with trees, one in some places may travel several hundred miles without seeing a tree. This appears difficult to be accounted for.

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square pieces be allowed to lie long in the lap without brakeing, they will become tough and not be easily reduced.

3. FORMING RIDGES.

THE first thing that occurs on this head, is to consider what grounds ought to be formed into ridges, what ought to be tilled with a flat surface. Dry soils, which suffer by lack of moisture, ought to be tilled flat, in order to retain moisture. And the method for such tilling, is to go round and round from the circumference to the centre, or from the centre to the circumference. This method is advantageous in point of expedition, as the whole is finished without once turning the plough. At the same time, every inch of the soil is moved, instead of leaving either the crown or the furrow unmoved, as is commonly done in tilling ridges. Clay soil, which suffers by water, ought to be laid as dry as possible by proper ridges. A loamy soil is the middle between the two. It ought to be tilled flat in a dry country, especially if it incline to the soil first mentioned. In a moist country, it ought to be formed into ridges, high or low according to the degree of moisture, and tendency to clay.

In grounds that require ridging, an error prevails, that ridges cannot be raised too high. High ridges labour under several disadvantages. The

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soil

soil is heaped upon the crown, leaving the furrows bare : the crown is too dry, and the furrows too wet : the crop, which is always best on the crown, is more readily shaken with the wind, than where the whole crop is of an equal height : the half of the ridge is always covered from the sun, a disadvantage which is far from being slight in a cold climate. High ridges labour under another disadvantage in ground that has no more level than barely sufficient to carry off water : they sink the furrows below the level of the ground ; and consequently retain water at the end of every ridge. The furrows ought never to be sunk below the level of the ground. Water will more effectually be carried off, by contracting the ridges both in height and breadth : a narrow ridge, the crown of which is but eighteen inches higher than the furrow, has a greater slope, than a very broad ridge where the difference is three or four feet.

Next of forming ridges where the ground hangs considerably. Ridges may be too steep as well as too horizontal ; and if to the ridges be given all the steepness of the field, a heavy shower may do irreparable mischief. One instance I was witness to. A hanging field had been carefully dressed with lime and dung for turnip. The turnip was fairly above ground, when a fatal summer-shower swept down turnip, lime, dung, and a quantity of the loose soil, leaving the land bare. To prevent such mischief, the ridges ought

ought to be so directed cross the field, as to have a gentle slope for carrying off water slowly, and no more. In that respect, a hanging field has greatly the advantage of one that is nearly horizontal; because in the latter, there is no opportunity of a choice in forming the ridges. A hill is of all the best adapted for directing the ridges properly. If the soil be gravelly, it may be plowed round and round, beginning at the bottom and ascending gradually to the top in a spiral line. This method of plowing a hill, requires no more force than plowing on a level: at the same time it removes the great inconvenience of a gravelly hill, that of rain going off too quickly; for the rain is retained in every furrow. If the soil be such as to require ridges, they may be directed to any slope that is proper. Columella, Book 2. chap. 5. advises, in plowing a hill the furrows to be directed cross the hill: which he observes is much easier than the plowing it up and down.

In order to form a field into ridges that has not been formerly cultivated, the rules mentioned are easily put in practice. But what if ridges be already formed, that are either crooked or too high? After seeing the advantage of forming a field into ridges, people were naturally led into an error, that the higher the better. But what could tempt them to make their ridges crooked? I answer, Not design, but the laziness of the driver suffering the cattle to turn too hastily

stily, instead of making them finish the ridge without turning. There is more than one disadvantage in this slovenly practice. First, the water, kept in by the curve at the end of every ridge, sours the ground. Next, as a plough has the least friction possible in a straight line, the friction must be increased in a curve, the back part of the mould-board pressing hard on the one hand, and the coulter pressing hard on the other. In the third place, the plough moving in a straight line, has the greatest command in laying the earth over. But where the straight line of the plough is applied to the curvature of a ridge in order to heighten it by gathering, the earth moved by the plough is continually falling back, in spite of the most skilful ploughman.

The inconveniencies of ridges high and crooked are so many, that one would be tempted to apply a remedy at any risk. And yet, if the soil be clay, I would not advise a tenant to apply the remedy upon a lease shorter than two nineteen years. In a dry gravelly soil, the work is not difficult nor hazardous. When the ridges are cleaved two or three years successively in the course of cropping, the operation ought to be concluded in one summer. The earth, by reiterated plowings, should be accumulated upon the furrows, so as to raise them higher than the crowns: they cannot be raised too high, for the accumulated earth will subside by its own weight.

Cross.

Cross-plowing once or twice, will reduce the ground to a flat surface, and give opportunity to form ridges at will. The same method brings down ridges in clay soil: only let care be taken to carry on the work with expedition; because a heavy shower before the new ridges are formed, will soak the ground in water, and make the farmer suspend his work for the remainder of that year at least. In a strong clay, I would not venture to alter the ridges, unless it can be done to perfection in one season.

In the operation of flattening ridges, there is a circumstance that has scarce ever been attended to. Ridges are evidently an improvement of art; and so is manure. The soil must have been exhausted by frequent cropping before either ridges or dung were attempted; and after ridges were formed, the soil under the crowns must continue in its exhausted state, being deprived of the benefit both of sun and rain. We find these conjectures verified by experience. When a ridged field is made level as originally, the soil immediately under the crown, which had the thickest covering, is commonly exceedingly poor. Farmers, sensible of this, never fail to give more dung to that part than to the rest of the field. But a more effectual remedy is, to pierce deeper than the original surface with the spade or plough, in order to bring up virgin soil. This soil is generally good; and the whole is made equally fertile, by mixing

mixing it with the exhausted soil in cross-plowing and harrowing. In the low country of Berwickshire, I frequently used this remedy, and never was disappointed. In making ditches there for draining, I have brought up a brick-clay lying four feet under the surface, which without being mellowed either by sun or frost, carried oats of a surprising size. Wild plants may be seen every where much larger than ordinary, growing even in gravel thrown up from the bottom of a new-made ditch*.

Let

* The instructions contained in this work regard a peopled country where every acre is occupied and pays rent. They cannot have place, where the corn-land, by paucity of inhabitants, bears no proportion to what is left waste; which was the case in Scotland two centuries ago, and is at present the case of North America. The prospect of dung will never engage a farmer to submit to the expence of feeding his cattle at home, when they can be maintained in the common without expence. Having thus little or no dung, the farmer crops field after field, till they can bear no more. He chooses fields that are dry; and when these are exhausted, he must attempt moist ground where ridges are necessary. Ridges thus introduced, were, from imitation and custom, extended to all grounds wet and dry. Dry fields exhausted by cropping without manure, were in some measure benefited by ridges, which brought up new soil to the surface, and thickened the crown of the ridge. But soil, rich or poor, when covered from the sun and rain by a thick coat of earth, will, as observed in the text, remain in that state for ever, without turning better or worse. The division of a farm into infield and outfield, once

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Let it be a rule, to direct the ridges north and south if the ground permit. In this direction, the east and west sides of a ridge, dividing the sun equally between them, will ripen at the same time.

It is a great advantage in agriculture, to form ridges so narrow, and so low, as to admit the crowns and furrows to be changed alternately every crop. The soil nearest the surface is the best; and by such plowing, it is always kept near the surface, and never buried. In high ridges, the soil is accumulated at the crown, and the furrows left bare. Such alteration of crown and furrow, is easy where the ridges are no more but seven or eight feet broad. This mode of plowing answers perfectly well in sandy and gravelly soils, and even in loam. But it is not safe in clay soil. In that soil, the ridges ought to be twelve feet wide and twenty inches high; to be preserved always in the same form by casting, that is, by plowing two ridges at a time, beginning at the furrow that separates them, plowing round that furrow, and so round and round till the two ridges be finished. By this method, the separating furrow is raised a little higher than the furrows that bound the two ridges. But at the

next
once universal in Scotland, and still frequent, proceeds from the same cause. We have therefore no reason to blame our forefathers for a practice perfectly well suited to a country slack of inhabitants.

next plowing, that inequality is corrected, by beginning at the bounding furrows, and going round and round till the plowing of the two ridges be completed at the separating furrow.

I cannot conclude this article without inveighing against the commons in England, which produce very little and are destructive by increasing the number of the idlers who subsist by charity. An act for dividing them, as in Scotland, would give work to many thousands, would increase population, would add greatly to the land product, and no less to the public revenue.

4. CLEARING GROUND OF WEEDS.

THE farmer views plants in a very different light from the botanist. All are weeds with the farmer that give obstruction to the plants he propagates in his farm. These I distinguish into two kinds, that require different management, *viz.*—first, annuals; and next, all that have a longer existence, which I shall comprehend under the general name of *perennials*. It is vain to expect a crop of corn from land over-run with couch-grass, knot-grass, or other perennial weeds; and yet the time may be remembered, when, among Scotch farmers, it was a disputed point, whether such weeds were not more profitable than hurtful. Some found them profitable in binding their light land: the getting a plentiful crop of straw and

and hay for their cattle, weighed with others. I should be ashamed of exposing ignorance so gross in my countrymen, could I not say, that they now understand the matter better, though few of them hitherto have arrived at the perfection of cleaning. Summer-fallow is the general method; and excellent it is, though it doth not always prove effectual. The roots of couch-grass in particular are long, and full of juice: if a single joint be left in the ground, it never fails to spring. Here the common harrow is of very little use, its teeth being too wide. The time relied on by our farmers for destroying couch-grass, is in preparing for barley. After the harrow has raised part of a root above ground, men, women, and children, are employed to pull it up. There are only two objections to this method: the expence is one; the other is, that after all this expence, many roots are left in the ground. In order to pave the way for rooting out perennials effectually, and with little expence, I take liberty to introduce a new instrument, which I term a *cleaning harrow*. It is of one entire piece, like the first of those mentioned above, consisting of seven bulls, four feet long each, two and one fourth inches broad, two and three fourths deep. The bulls are united together by cross bars, similar to what are mentioned above. The intervals between the bulls being three and three fourths inches, the breadth of the whole harrow

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is three feet five inches. In each bull are inserted eight teeth, each nine inches free below the wood, and distant from each other six inches. The weight of each tooth is a pound, or near it. The whole is firmly bound by an iron plate from corner to corner in the line of the draught. The rest as in the harrows mentioned above. The size, however, is not invariable. The cleaning harrow ought to be larger or less according as the soil is stiff or free. See the figure annexed.

To give this instrument its full effect, stones of such a size as not to pass freely between the teeth, ought to be carried off, and clods of that size ought to be broken. The ground ought to be dry, which it is commonly in the month of May.

In preparing for barley, turnip, or other summer-crop, begin with plowing and cross-plowing. If the ground be not sufficiently pulverized, let the great brake be applied, to be followed successively with the harrows, No. 1. and No. 2. In stiff soil rolling may be proper, once or twice between the acts. These operations will loosen every root, and bring some of them to the surface. This is the time for the harrow, No. 3. conducted by a boy mounted on one of the horses, who trots smartly along the field, and brings all the roots to the surface: there they are to lie for a day or two till perfectly dry. If any stones or clods remain, they must be carried off
in

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in a cart. And now succeeds the operation of the cleaning harrow. It is drawn by a single horse, directed by reins, which the man at the opposite corner puts over his head, in order to have both hands free. In this corner is fixed a rope, with which the man from time to time raises the harrow from the ground, to let the weeds drop. For the sake of expedition, the weeds ought to be dropt in a straight line cross the field, whether the harrow be full or no; and seldom is a field so dirty but that the harrow may go thirty yards before the teeth are filled. The weeds will be thus laid in parallel rows, like those of hay raked together for drying. A harrow may be drawn swiftly along the rows, in order to shake out all the dust; and then the weeds may be carried clean off the fields in carts. But we are not yet done with these weeds: instead of burning, which is the ordinary practice, they may be converted into useful manure, by laying them in a heap with a mixture of hot dung to begin fermentation. What better politic than to make a friend of a foe! At first view, this way of cleaning land will appear operose; but upon trial, neither the labour nor the expence will be found immoderate. So far from it, that I believe it will not be easy to name any other way of cleaning ground effectually that costs so little. At any rate, the labour and expence ought not to be grudged; for if a field be once thoroughly

thoroughly cleaned, the seasons must be very cross, or the farmer very indolent, to make it necessary to renew the operation in less than twenty years *.

Moss is one of the most pernicious weeds that enter into a grass-field: in a very dry soil, it usurps upon the good plants, wears them out, and covers the whole surface. I have tried lime and dung to very little purpose. Coal-ashes do better: they keep it back a few years; but it recovers strength gradually as the ashes lose their influence, and prevails as much as before. Some writers talk of rolling, because moss is never seen on a foot-path. They do not advert, that the continual treading of feet on a narrow path, consolidates the ground more, and makes it more retentive

* Since the last edition, a letter recieved from a gentleman no less accurate than skilful in husbandry, is in the following words: "The ground preparing for turnip was very foul. I caused harrow it with common harrows as well as possible, and employed people with rakes to gather the wreck. When the common harrows could do no more service, I employed your cleaning harrow, which from four acres and a half brought to the surface as much wreck as loaded ten single horse carts. I tried it again this summer on a small bit of ground, about a quarter of an acre, near my house, in order to lay it down with grass seeds. After the common harrows and gardeners with rakes, had cleaned it as well as they could, a quantity was gathered by your cleaning harrow that filled four of the carts mentioned."

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retentive of moisture, than rolling can do. Nor do they advert, that moss is the most plentiful in dry ground, where the weightiest roller makes no impression. As moss prospers the most on the driest ground, the laying the field under water a whole winter, will destroy it. There is reason however to suspect, that it will encroach again, when the moisture is exhausted, and the soil returns to its arid state; not to mention the many fields that lie out of the reach of water. One infallible method there is; which is, to cover the ground an inch thick with soil retentive of moisture; and to mix it with the original soil by the plough and harrow. Thus will moss be banished, and the soil at the same time enriched. But the good soil here must be at hand; it would be too expensive to bring it from a distance. Lucky it is, after all, that there still remains an infallible method, which, instead of being expensive, is extremely profitable. It will be made evident afterward, in laying down rules for rotation of crops, that a quick succession of corn and grass, is more profitable, than to allow any ground to continue long in either. Therefore, as soon as moss begins to prevail, plow up the ground for a crop of corn *.

Next,

* The following method is proposed by Dr Home for destroying moss. "Shut up the inclosure from the middle of May till the beginning of December: feed it till April,

Next, of annual weeds, which are propagated by seed. As seeds cannot be gathered out of the ground like roots, the only way of destroying them, is to promote their vegetation ; which lays them open to be extirpated by the plough or harrow. For want of industry, annual weeds prevail in many parts of this island, in the best soils especially. To view a crop near a town, end of May, or beginning of June, one would believe it to be a crop of charlock or wild mustard. These plants, it is true, lose their splendid appearance after their flowering is over ; but they remain to encumber the ground. As they ripen, and drop their seed long before the corn is ripe, they multiply more and more. They not only rob the ground, and starve the good grain, but prevent circulation of air about the roots, which is a great impediment to vegetation. Freedom of circulation is one of the causes that make drilled crops succeed so well. What must have been the condition of corn-land in Scotland before fallowing was known !

And

“ prill, and then save it for a crop of hay. The moss being so long covered with grass, is cut off from the benefit of the air, and dies.” I doubt. Over-shadowing may retard its progress ; but as over-shadowing does not correct the dryness of the soil, it is not likely to complete the cure. A haugh on the river Nith was over-run with moss, and lime proved a cure. But moss growing on a rich haugh at the side of a river must be different from what grows on a dry gravelly soil that holds no water,

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And now to the destruction of such weeds. Summer-fallow, among its other advantages, does this effectually, by observing the following method. Begin with plowing in April as soon as the ground is dry; and let the brake succeed cross the field; which by pulverising the soil, will promote the vegetation of every seed. As soon as the weeds appear, which may be in ten or twelve days according to the season, plow and brake as before: the plough will make many seeds vegetate; the brake still more. Proceed in the same course while any weeds appear. In the heat of summer, rolling not only promotes vegetation by keeping in the moisture, but bruises the clods which lock up many seeds.

This process requires the following precaution. Avoid plowing or brakeing when the ground is wet. The stirring wet ground hardens it, excludes the sun and air, and prevents vegetation.

C H A P. V.

CULTURE OF PLANTS FOR FOOD.

THE articles hitherto insisted on, are all of them preparatory to the capital object of a farm, that of raising plants for the nourishment of man, and of other animals. These are of
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two kinds; culmiferous, and leguminous, differing widely from each other. Wheat, rye, barley, oats, ryegrass, are of the first kind: of the other kind are pease, beans, clover, cabbage, and many others. Culmiferous plants, says Bonnet, have three sets of roots. The first issue from the seed, and push to the surface an upright stem; another set issue from a knot in that stem; and a third, from another knot, nearer the surface. Hence the advantage of laying seed so deep in the ground as to afford space for all the sets. Leguminous plants form their roots differently. Pease, beans, cabbage, have store of small roots, all issuing from the seed, like the undermost set of culmiferous roots; and they have no other roots. A potato and a turnip have bulbous roots. Red clover has a strong tap-root. The difference between culmiferous and leguminous plants with respect to the effects they produce in the soil, will be explained afterward, in the chapter concerning rotation of crops. As the present chapter is confined to the propagation of plants, it falls naturally to be divided into three sections: First, plants cultivated for fruit; Second, plants cultivated for roots; Third, plants cultivated for leaves.

SECTION I.

PLANTS CULTIVATED FOR FRUIT.

WHEAT, rye, oats, barley, beans, and pease, are the plants that are mostly cultivated in Scotland for fruit. I begin with wheat and rye.

I. WHEAT and RYE.

As soon in spring as the ground is fit for plowing, the fallowing for wheat may commence. The moment should be chosen, when the ground, beginning to dry, has yet some remaining softness: in that condition, the soil divides easily by the plough, and falls into small parts. This is an essential article, deserving the strictest attention of the farmer. Ground plowed too wet, rises, as we say, *whole-fur*, as when pasture-ground is plowed: where plowed too dry, it rises in great lumps, which are not reduced by subsequent plowings; not to mention, that it requires double force to plow ground too dry, and that the plough is often shattered. When the ground is in proper order, the farmer can have no excuse for delaying a single minute. This first course of fallow, must, it is true, yield to the barley-feed; but as the barley-feed is commonly over the first

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week of May, or sooner, the season must be unfavourable if the fallow cannot be reached by the middle of May.

As clay soil requires high ridges, these ought to be cleaved at the first plowing, beginning at the furrow, and ending at the crown. This plowing ought to be as deep as the soil will admit; and water-furrowing ought instantly to follow: for if rain happen before water-furrowing, it stagnates in the furrow, necessarily delays the second plowing till that part of the ridge be dry, and prevents the furrow from being mellowed, and roasted by the sun. If this first plowing be well executed, annual weeds will rise in plenty. About the first week of June, the great brake will loosen and reduce the soil, encourage a second crop of annuals, and raise to the surface the roots of weeds moved by the plough. Give the weeds time to spring, which may be in two or three weeks. Then proceed to the second plowing about the beginning of July; which must be cross the ridges, in order to reach all the slips of the former plowing. By cross-plowing, the furrows will be filled up, and water-furrowing be still more necessary than before. Employ the brake again about the 10th of August, to destroy the annuals that have sprung since the last stirring. The destruction of weeds is a capital article in fallowing: yet so blind are people to their interest, that nothing is more common, than

a fallow field covered with charlock and wild mustard, all in flower, and ten or twelve inches high. The field having now received two harrowings and two brakeings, is prepared for manure, whether lime or dung, which without delay ought to be incorporated with the soil, by repeated harrowing and a gathering furrow. This ought to be about the beginning of September; and as soon after as you please the seed may be sown.

As in plowing a clay soil it is of importance to prevent poaching, the hinting furrows ought to be done with two horses in a line. If four ploughs be employed in the same field, to one of them may be allotted the care of the hinting furrows. What will one think, who has never been in the Highlands, of four horses abreast in a plough, the driver going backward, and striking the horses on the forehead to make them come forward? The ignorant and illiterate are strangely dull in point of invention: let the most stupid practice turn once customary, and it is rivetted in them for ever. Is it not obvious, that four horses abreast must tread down the new-moved soil, and reduce it to as firm a state as before the plough entered?

Next of dressing loam for wheat. Loam, being a medium between sand and clay, is of all soils the fittest for culture, and the least subject to chances. It does not hold water like clay;
and

and when wet, is sooner dry. At the same time, it is more retentive than sand of that degree of moisture which promotes vegetation. On the other hand, it is more subject to couch-grass than clay, and to other weeds; to destroy which, fallowing is still more necessary than in clay.

Beginning the fallow about the first of May, or as soon as barley-seed is over, take as deep a furrow as the soil will admit. Where the ridges are so low and narrow as that the crown and furrow can be changed alternately, there is little or no occasion for water-furrowing. Where the ridges are so high as to make it proper to cleave them, water-furrowing is proper. The second plowing may be at the distance of five weeks. Two crops of annuals may be got in the interim, the first by the brake, and the next by the harrow; and by the same means eight crops may be got in the season. The ground must be cleared of couch-grass and knot-grass roots, by the cleaning harrow, described above. The time for this operation is immediately before the manure is laid on. The ground at that time being in its loosest state, parts with its grass-roots more freely than at any other time. After the manure is spread, and incorporated with the soil by braking or harrowing, the seed may be sown under furrow if the ground hang so as easily to carry off the moisture. To leave it rough without harrowing, has two advantages; it is not apt to
cake

cake with moisture ; and the inequalities make a sort of shelter to the young plants against frost. But if it lie flat, it ought to be smoothed with a slight harrow after the seed is sown, which will facilitate the course of the rain from the crown to the furrow.

A sandy soil is too loose for wheat. The only chance for a crop is after red clover, the roots of which bind the soil ; and the instructions above given for loam are applicable here. Rye is a crop much fitter for sandy soil than wheat ; and like wheat it is generally sown after a summer-fallow.

Lastly, Sow wheat as soon in the month of October as the ground is ready. When sown a month more early, it is too forward in the spring, and apt to be hurt by frost : when sown a month later, it has not time to root before frost comes on, and frost spews it out of the ground.

2. O A T S.

As winter-plowing enters into the culture of oats, I must remind the reader of the effect of frost upon tilled land. Providence has neglected no region intended for the habitation of man. If in warm climates the soil be meliorated by the sun, it is no less meliorated by frost in cold climates. Frost acts upon water, by expanding it
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and making it to occupy a larger space. Frost has no effect upon dry earth ; witness sand upon which it makes no impression. But upon wet earth it acts most vigorously : it expands the moisture, which puts every particle of the earth out of its place, and separates them from each other. In that view, frost may be considered as a plough superior to any that can be made by the hand of man : its action reaches the minutest particles ; and, by dividing and separating them, it renders the soil loose and friable. This operation is the most remarkable in tilled land, which gives free access to frost. With respect to clay soil in particular, there is no rule in husbandry more essential than to open it before winter in hopes of frost. It is even advisable in a clay soil to leave the stubble rank, which, when plowed in before winter, keeps the clay loose, and admits the frost into every cranny.

To apply this doctrine, it is dangerous to plow clay soil when wet ; because water is a cement for clay, and binds it so as to render it unfit for vegetation. It is however less dangerous to plow wet clay before winter than after. A succeeding frost corrects the bad effects of such plowing : a succeeding drought encreases them. No rule is so easy to be followed as what I am inculcating ; and yet no other is so frequently transgressed. Many farmers have a sort of bastard industry,

industry, that prompts activity without ever thinking of consequences.

And now to the culture of oats, a culmiferous plant. The common method is, to sow them on new-plowed land in the month of March, as soon as the ground is tolerably dry. If it continue wet all the month of March, it is too late to venture them after. It is much better to summer-fallow and to sow wheat in the autumn. But the preferable method, especially in clay soil, is to turn over the field after harvest, and to lay it open to the influences of frost and air, which lessen the tenacity of clay, and reduce it to a free mould. The surface-soil by this means is finely mellowed for reception of the seed; and it would be a pity to bury it by a second plowing before sowing. In general, the bulk of clay soils are rich; and skilful plowing without dung, will probably give a better crop than unskilful plowing with dung.

Hitherto of natural clays. I must add a word of carse clays which are artificial, whether left by the sea, or swept down from higher grounds by rain*. The method commonly used of dressing carse clay for oats, is, not to stir it till the ground be dry in the spring, which seldom happens before the first of March; and the seed is sown as soon after as the ground is sufficiently dry for its reception. Frost has a stronger effect on such clays than on natural clay. And if the field be

* See carse clay described Part II. chap. I. § 1.

be laid open before winter, it is rendered so loose by frost as freely to admit rain. The particles at the same time are so small, as that the first drought in spring makes the surface cake or crust. The difficulty of reducing this crust into mould for covering the oat-seed, has led farmers to delay plowing till the month of March. But we are taught by experience, that this soil plowed before winter, is sooner dry than when the plowing is delayed till spring; and as early sowing is a great advantage, the objection of the superficial crusting is easily removed by the harrow, No. 1. above described, which will produce abundance of mould for covering the seed. The plowing before winter not only procures early sowing, but has another advantage: the surface-soil that had been mellowed during winter by the sun, frost, and wind, is kept above. I have no experience of managing carse clay in this manner; but to me it appears greatly preferable to the common practice. One accurate experiment I am informed of, that justifies my opinion. A carse field was cleaved in October as a preparation for the next year's fallow. One ridge happened to be left, which was not tilled till the beginning of March following. At the end of that month after a fall of rain, the early tilled ground was dry, and the ridge very wet.

The dressing a loamy soil for oats, differs little from dressing a clay soil, except in the following particular,

particular, that being less hurt by rain, it requires not high ridges; and therefore ought to be plowed crown and furrow alternately.

Where there is both clay and loam in a farm, it is obvious from what is said above, that the plowing of the clay after harvest, ought first to be dispatched. If both cannot be overtaken that season, the loam may be delayed till the spring with less hurt.

Next of a gravelly soil; which is the reverse of clay, as it never suffers but from want of moisture. Such a soil ought to have no ridges; but plowed circularly from the centre to the circumference, or from the circumference to the centre. It ought to be tilled after harvest; and the first dry weather in spring ought to be laid hold of to sow, harrow, and roll; which will preserve it in lap. One used to ridges may find some difficulty in sowing without them. But a proper breadth may be marked, either with poles or by the sower's confining himself to a certain number of the circular furrows.

The culture of oats is the simplest of all. That grain is probably a native of Britain: it will grow on the worst soil with very little preparation. For that reason, before turnip was introduced, it was always the first crop upon land broken up from the state of nature.

Upon such land, may it not be a good method, to build up on the crown of every ridge, in the

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form

form of a wall, all the surface earth, one sod above another, as in a fold for sheep? After standing in this form all the summer and winter, let the walls be thrown down, and the ground prepared for oats. This will secure one or two good crops; after which the land may be dunged for a crop of barley and grass-seeds. This method may answer in a farm where manure is scanty.

3. BARLEY.

BARLEY is a culmiferous plant that requires a mellow soil. Upon that account, extraordinary care is requisite where it is to be sown in clay. The land ought to be stirred immediately after the foregoing crop is removed, which lays it open to be mellowed with frost and air. In that view, a peculiar sort of plowing has been introduced, termed *ribbing*; by which the greatest quantity of surface possible is exposed to air and frost. The obvious objection to this method is, that half of the ridge is left unmoved. And to obviate that objection, I offer the following method, which moves the whole soil, and at the same time exposes the same quantity of surface to frost and air. This I esteem a valuable improvement; and I am only in pain about making it to be clearly understood. As soon as the former crop is off the field, let the ridges be gathered with as deep a furrow as the soil will admit,

mit, beginning at the crown and ending at the furrows. This plowing loosens the whole soil, giving free access to air and frost. Soon after, begin a second plowing in the following manner. Let the field be divided by parallel lines cross the ridges, with intervals of thirty feet or so. Plow once round an interval, beginning at the edges, and turning the earth toward the middle of the interval; which covers a foot or so of the ground formerly plowed. Within that foot plow another round similar to the former; and after that other rounds, till the whole interval be finished, ending at the middle. Instead of beginning at the edges, and plowing toward the middle, it will have the same effect to begin at the middle and to plow toward the edges. Plow the other intervals, in the same manner. As this operation will fill up the furrows, let them be cleared and water-furrowed without delay. By this method, the field will be left waving like a plot in a kitchen-garden, ridged up for winter. In this form, the field is kept perfectly dry; for beside the capital furrows that separate the ridges, every ridge has a number of cross furrows that carry the rain instantly to the capital furrows. In hanging grounds retentive of moisture, the parallel lines above-mentioned ought not to be perpendicular to the furrows of the ridges, but to be directed a little downward, in order to carry rain-water the more

hastily

hastily to these furrows. If the ground be clean, it may lie in that state winter and spring, till the time of seed-furrowing. If weeds happen to rise, they must be destroyed by plowing, or brakeing, or both; for there cannot be worse husbandry, than to put seed into dirty ground.

This method resembles common ribbing in appearance, but is very different in reality. As the common ribbing is not preceded by a gathering furrow, the half of the field is left untilled, firm as when the former crop was removed, impervious in a great measure to air or frost. It at the same time lodges the rain-water on every ridge, preventing it from descending to the furrows; which is hurtful in all soils, and poisonous in a clay soil. The stitching here described, or ribbing if you please to call it so, prevents these noxious effects. By the two plowings the whole soil is opened, admitting freely air and frost; and the multitude of furrows lays the surface perfectly dry, giving an early opportunity for the barley-feed.——But I have more to say in favour of the method proposed. When it is proper to sow the seed, all is laid flat with the brake, which is an easy operation upon soil that is dry and pulverized; and the seed-furrow which succeeds, is so shallow as to bury little or none of the surface-earth: whereas the stirring for barley is commonly done with the deepest furrow; and consequently buries all the surface-soil that was mel-
lowed

lowed by the frost and air. Nor is this method more expensive; because the common ribbing must always be followed with a stirring furrow, which is saved in the method recommended. Nay, it is less expensive; for after common ribbing, which keeps in the rain-water, the ground is commonly so soured, as to make the stirring a laborious work.

Where the land is in good order, and free of weeds, April is the month for sowing barley. Every day is proper from the first to the last. But in a light soil, the later part of the month is the safest. Three lippies sown first of April, were cut twelfth of August. The increase was 36 lippies, weighing at the rate of 18 stone *per* boll. The straw weighed 17 stone and 8 pounds. In the same field, all of one soil, other three lippies were sown first of May and cut sixth of September. The increase 67 lippies, or one boll and three lippies, weighing as the former did at the rate of 18 stone *per* boll. The straw weighed 30 stone.

The dressing loamy soil and light soil for barley, is the same with that described; only that to plow dry is not altogether so essential as in dressing clay soil. Loam or sand may be stirred a little moist: better, however, delay a week or two, than to stir a loam when moist. Clay must never be plowed moist, even though the season should escape altogether. But this will seldom
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be necessary ; for not in one year of twenty will it happen, but that clay is dry enough for plowing some time in May. Frost may correct clay plowed wet after harvest ; but plowed wet in spring, it unites into a hard mass, not to be dissolved but by very hard labour.

The foregoing culmiferous plants are what are ordinarily propagated for food in Scotland. What follow are leguminous plants. And I begin with beans, being sown the earliest in spring.

4. B E A N S.

THE properest soil for beans is a deep and moist clay.

There was lately introduced into Scotland a method of sowing beans with a drill-plough, and horse-hoeing the intervals ; which, beside affording a good crop, is a dressing to the ground. But as that method is far from being general, I keep in the common track.

As this grain is early sown, the ground intended for it should be plowed before winter, to give access to frost and air ; beneficial in all soils, and necessary in a clay soil. Take the first opportunity after January when the ground is dry, to loosen the soil with the harrow first described, till a mould be brought upon it. Sow the seed, and cover it with the second harrow. The third will smooth

smooth the surface, and cover the seed equally. These harrows make the best figure in covering beans, which by them can be laid deeper in the ground than by the ordinary harrows: In clay soil, the common harrows are altogether insufficient. The soil that has rested long after plowing, is rendered compact and solid: the common harrows skim the surface: the seed is not covered; and the first hearty shower of rain lays it above ground. Where the farmer overtakes not the plowing after harvest, and is reduced to plow immediately before sowing, the plough answers the purpose of the first harrow; and the other two will complete the work. But the labour of the first harrow is ill saved; as the plowing before winter is a fine preparation, not only for beans, but for grain of every kind. If the ground plowed before winter happen by superfluity of moisture to cake, the first harrow going along the ridges, and crossing them, will loosen the surface, and give access to air for drying. As soon as the ground is dry, sow without delaying a moment. If rain happen in the interim, there is no remedy but patience till a dry day or two come.

Carse clay, plowed before winter, seldom fails to cake. Upon that account, a second plowing is necessary before sowing; which ought to be performed with an ebb furrow, in order to keep the frost-mould as near the surface as possible. To cover the seed with the plough is expressed by the

the phrase *to sow under furrow*. The clods raised in this plowing, are a sort of shelter to the young plants in the chilly spring-months.

The foregoing method will answer for loam. And as for a sandy or gravelly soil, it is altogether improper for beans.

Though I cannot recommend the horse-hoeing of beans, with the intervals that are commonly allotted for turnip, yet I warmly recommend the drilling them at the distance of ten or twelve inches, and keeping the intervals clean of weeds. This may be done by hand-hoeing, taking opportunity at the same time to lay fresh soil to the roots of the plants. But as this is an expensive operation, and hands are not always to be got, I propose a narrow plough, drawn by a single horse, with a mouldboard on each side to lay the earth upon the roots of the plants. This is a cheap and expeditious method: it keeps the ground clean; and nourishes the plants with fresh soil *.

As
* Cornelius Celsus declares against weeding or hoeing beans; because, says he, "after having pulled them up with the hand, a crop of grass remains for making hay." I have often regretted the loss of that author's work upon husbandry; because, from that on medicine, he appears a first rate genius. But, if we can trust to a specimen, the loss is not great. Columella, book 2d, ch. 12th, justly condemns him for this doctrine. "It appears, (says he,) bad husbandry to suffer weeds to grow up with corn, which must deprive the corn of so much nourishment." He adds, with respect to beans in particular, "that the keeping them clean produces much meal and a very thin husk."

As beans delight in a moist soil, and have no end of growing in a moist season, they cover the ground totally when sown broadcast, keep in the dew, and exclude the sun and air: the plants grow to a great height, but carry little seed, and that little not well ripened. This displays the advantage of drilling, which gives free access to the sun and air, dries the ground, and affords plenty of ripe seed.

5. P E A S E.

PEASE are of two kinds; the white, and the gray. The latter is what generally is cultivated in Scotland for fruit; and the latter only shall be here handled, leaving the former to gardeners.

There are two species of the gray kind, distinguished by their time of ripening. One ripens soon, and for that reason is termed *hot seed*: the other, which is slower in ripening, is termed *cold seed*. Whether these be really different species, or be accidentally different only, is left to natural philosophers.

Pease, a leguminous crop, is proper to intervene between two culmiferous crops; less for the profit of a pease-crop, than for meliorating the soil. Pease however in a dry season will produce six or seven bolls each acre; but in an ordinary season they seldom reach above two or two and a half. This leads me to think, that in a moist

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climate,

climate, which all the west of Britain is, red clover is a more beneficial crop; as it makes as good winter-food as pease, and can be cut green thrice during summer. When husbandry comes to be better understood, I have little doubt but that red clover will banish pease altogether, except in the warmest and driest spots.

A field intended for cold seed ought to be plowed in October or November; but the seed ought not to be put into the ground before March: more early sowing subjects the tender plants to the nipping cold of April. A field intended for hot seed, ought to be plowed the middle or end of April immediately before sowing. But if infested with weeds, it ought to be also plowed in October or November.

Pease laid a foot below the surface will vegetate: but the most approved depth is six inches in light soil, and four inches in clay soil; for which reason, they ought to be sown under furrow when the plowing is delayed till spring. Of all grain, beans excepted, they are the least in danger of being buried.

Pease differ from beans, in loving a dry soil and a dry season. Horse-hoeing would be a great benefit, could it be performed to any advantage; but pease grow expeditiously, and soon fall over and cover the ground, which bars plowing. Horse-hoeing has little effect when the plants are new sprung; and when they are advanced.

vanced to be benefited by that culture, their length prevents it. Fast growing at the same time is the cause of their carrying so little seed : the seed is buried among the leaves ; and the sun cannot penetrate to make it grow and ripen. For the same reason, in a pease crop, there is always more grain on the west side of the ridge than on the east side. The plants are commonly laid over by the west wind, and smother the seed on the east side. The only practicable method to obtain grain, is thin sowing ; but thick sowing produces more straw, and mellows the ground more. Half a boll for an English acre may be reckoned thin sowing ; three firlots, thick sowing.

Notwithstanding what is said above, Mr Hunter, a noted farmer in Berwickshire, has begun of late to sow all his pease in drills ; and he never fails to have great crops of corn as well as of straw. He sows double rows with a foot interval, and two feet and a half between the double rows, which admit horse-hoeing. By that method, he has also good crops of beans on light land.

Pease and beans mixed are often sown together, in order to catch different seasons. In a moist season, the beans make a good crop ; in a dry season, the pease.

The growth of plants is commonly checked by drought in the month of July ; but promoted by
rain

rain in August. In July, grass is parched; in August, it recovers verdure. Where pease are so far advanced in the dry season as that the seed begins to form, the growth of the plants is indeed checked, but the seed continues to fill. If the plants are only in the blossom at that season, their growth is checked a little; but they become vigorous again in August, and continue growing without filling till stopped by frost. Hence it is, that cold seed, which is early sown, has the best chance to produce corn: hot seed, which is late sown, has the best chance to produce straw.

The following method is practised in Norfolk, for sowing pease upon a dry light soil, immediately opened from pasture. The ground is pared with a plough extremely thin, and every sod is laid exactly on its back. In every sod a double row of holes is made. A pea dropt in every hole lodges in the flay'd ground immediately below the sod, thrusts its roots horizontally, and has sufficient moisture. This method enabled Norfolk farmers, in the barren year 1740, to furnish white pease to us at 12 s. per boll.

S E C T. II.

PLANTS CULTIVATED FOR ROOTS.

PLANTS of that kind commonly cultivated in the field, are turnip, potatoes, carrot, parsnip.

1. T U R-

I. TURNIP.

It animates me to have opportunity for giving directions about a crop, that the best farmers in this country have now taken into their plan of husbandry; and that does not altogether escape even small farmers. Nor am I acquainted with a single instance in Scotland, where turnip fairly begun have been relinquished.

The proper soil for turnip is a gravelly soil; and there it can be raised to the greatest perfection, and with the least hazard of miscarrying. At the same time, there is no soil but will bear turnip when well prepared.

No person ever deserved better of a country, than he who first cultivated turnip in the field. No plant is better fitted for the climate of Britain, no plant prospers better in the coldest parts of it, and no plant contributes more to fertility. In a word, there has not for two centuries been introduced into Britain a more valuable improvement.

Of all roots, turnip requires the finest mould; and to that end, of all harrows frost is the best. In order to give access to frost, the land ought to be prepared by ribbing after harvest, as above directed in preparing land for barley. If the field be not subject to annuals, it may lie in that state till the end of May; otherwise the weeds must

must be destroyed by a brakeing about the middle of April ; and again in May, if weeds rise. The first week of June, plow the field with a shallow furrow. Lime it if requisite, and harrow the lime into the soil. Draw single furrows with intervals of three feet, and lay dung in the furrows. Cover the dung sufficiently, by going round it with the plough, and forming the three feet spaces into ridges. The dung comes thus to lie under the crown of every ridge.

The season of sowing must be regulated by the time intended for feeding. Where intended for feeding in November, December, January, and February, the seed ought to be sown from the 1st to the 20th of June. Where the feeding is intended to be carried on till March, April, and May, the seed must not be sown till the end of July. Turnip sown earlier than above directed, flowers that very summer, and runs fast to seed ; which renders it in a good measure unfit for food. If sown much later, it does not apple, and there is no food but from the leaves.

Though by a drill-plough the seed may be sown of any thickness, the safest way is to sow thick. Thin-sowing is liable to many accidents, which are far from being counterbalanced by the expence that is saved in thinning. Thick-sowing can bear the ravage of the black fly, and leave a sufficient crop behind. It is a protection against drought, gives the plants a rapid progress, and establishes

Ch.V. 2. CULTURE OF PLANTS FOR FOOD. III

establishes them in the ground before it is necessary to thin them.

The sowing turnip broadcast is universal in England, and common in Scotland, though a barbarous practice. The eminent advantage of turnip is, that, beside a profitable crop, it makes a most complete fallow; and the latter cannot be obtained but by horse-hoeing. Upon that account, I recommend with confidence the sowing turnip in rows at three feet distance: wider rows answer no profitable end, straiter rows afford not room for a horse to walk in. When the turnip is about four inches high, annual weeds will appear. Go round every interval with the slightest furrow possible, at the distance of two inches from each row, moving the earth from the rows toward the middle of the interval. A thin plate of iron must be fixed on the left side of the plough, to prevent the earth from falling back, and burying the turnip. Next, let women be employed to weed the rows with their fingers; which is better, and cheaper done, than with the hand-hoe. The hand-hoe, beside, is apt to disturb the roots of the turnip that are to stand, and to leave them open to drought by removing the earth from them. The standing turnip are to be at the distance of twelve inches from each other: a greater distance makes them swell too much; a less distance affords them not sufficient room. A woman soon becomes expert in finger-weeding.

weeding. The following hint may be necessary to a learner. To secure the turnip that is to stand, let her cover it with the left hand; and with the right pull up the turnip on both sides. After thus freeing the standing turnip, she may safely use both hands. Let the field remain in this state, till the appearance of new annuals make a second plowing necessary; which must be in the same furrow with the former, but a little deeper. As in this plowing the iron plate is to be removed, part of the loose earth will fall back on the roots of the plants: the rest will fill the middle of the interval, and bury every weed. When weeds begin again to appear, then is the time for a third plowing in an opposite direction, which lays the earth to the roots of the plants. This plowing may be about the middle of August, after which, weeds rise very faintly. If they do rise, another plowing will clear the ground of them. Weeds that at this time rise in the row, may be cleared with a hand-hoe, which can do little mischief among plants distant twelve inches from each other. I am certain however from experience, that it may be done cheaper with the hand*. And after that the leaves of turnips in a

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* Children under thirteen may be employed to weed turnip with the fingers. I have seen them go on in that work with alacrity; and a small premium will have a good effect.

row meet together, the hand is the only instrument that can be applied for weeding.

Tull was the father of horse-hoeing husbandry; and to desert his method requires an apology. The apology I make is, that the method I prescribe, and have long practised, is more simple, less operose, and, as far as I can judge, equally successful. Our farmers ought to be excited by every motive to embrace the cultivation of turnip; and nothing will contribute more than to render it easy and simple. Tull's method is not a little intricate; and to its intricacy, I am persuaded, is owing the neglect of it in England.

In Yorkshire the lambs are fed in July in a turnip field. They eat the weeds without touching the young turnip. Why should we clean a field for turnip, they will say, when it deprives the lambs of their food?

Where land is clean and the soil well pulverized, a crop of turnip may be procured with very little trouble. The field being laid flat without ridges, cover it with well rotted dung. With a plough having a double mouldboard, make furrows having intervals of three feet, which will mix the dung with the soil, and make three feet ridges; on the crowns of which drill the seed. As soon as weeds begin to appear, a deeper furrow with the same plough will bury the young weeds. Thin the turnip in the rows when two inches high, and gather clean earth to their roots.

If the land was perfectly clean, this will be sufficient for a good crop.

In swampy ground, the surface of which is best reduced by paring and burning, the seed may be sown in rows with intervals of a foot. To save time, a drill-plough may be used that sows three or four rows at once. Hand-hoeing is proper for such ground; because the soil under the burnt *stratum* is commonly full of roots, which digest and rot better under ground than when brought to the surface by the plough. In the mean time, while these are digesting, the ashes will secure a good crop.

The black fly is a great enemy to turnip; and I may justly say the only enemy, because every other article can be secured, by skill and diligence in the husbandman. In a rich and warm soil, where the black fly is instinctively directed to deposit its eggs, I take it to be an unconquerable enemy. Our only security is, to change the field of battle, by raising turnip in a moorish ground, or in ground newly broken up, according to the directions given above*.

2. P O T A T O E S.

THE choice of soil is not of greater importance in any other plant than in a potato. This plant in clay soil, or in rank black loam lying low

* Chap. 4. § 2.

low without ventilation, never makes palatable food. In a gravelly or sandy soil, exposed to the sun and to free air, it thrives to perfection, and has a good relish. But a rank black loam, tho' improper to raise potatoes for the table, produces them in great plenty; and the product is good and wholesome food for horned cattle, hogs and poultry.

The spade is a proper instrument for raising a small quantity, or for preparing corners or other places inaccessible to the plough; but for raising potatoes in quantities, the plough is the only instrument.

As two great advantages of a drilled crop, are, to destroy weeds, and to have a fallow at the same time with the crop, no judicious farmer will think of raising potatoes in any other way. In September or October, as soon as that year's crop is removed, let the field have a rousing furrow, a cross-brakeing next, and then cleared of weeds by the cleaning harrow. Form it into three-foot ridges, in that state to lie till April, which is the proper time for planting potatoes. Cross-brake it to raise the furrows a little. Then lay well-digested horse-dung along the furrows, upon which lay the roots at eight inches distance. Cover up these roots with the plough, going once round every row. This makes a warm bed for the potatoes; hot dung below, and a loose covering above, that admits every ray of the sun.

fun. As soon as the plants appear above ground, go round every row a second time with the plough, which will lay upon the plants an additional inch or two of mould, and at the same time bury all the annuals; and this will complete the plowing of the ridges. When the potatoes are six inches high, the plough, with the deepest furrow, must go twice along the middle of each interval in opposite directions, laying earth first to one row, and next to the other. And to perform this work, a plough with a double mould-board will be more expeditious. But as the earth cannot be laid close to the roots by the plough, the spade must succeed, with which four inches of the plants must be covered, leaving little more but the tops above ground; and this operation will at the same time bury all the weeds that have sprung since the former plowing. What weeds arise after, must be pulled up with the hand. A hoe is never to be used here: it cannot go so deep as to destroy the weeds without cutting the fibres of the plants; and if it skim the surface, it only cuts off the heads of the weeds, and does not prevent their pushing again.

The shortest and most perfect method of taking up potatoes, is to plow once round every row at the distance of four inches, removing the earth from the plants, and gathering up with the hand all the potatoes that appear. The distance is made four inches to prevent cutting the roots, which

which are seldom found above that distance from the row on each side. When the ground is thus cleared by the plough, raise the potatoes with a fork having three broad toes or claws, which is better than a spade, as it does not cut the potatoes. The potatoes thus laid above ground, must be gathered with the hand. By this method scarce a potato will be left.

As potatoes are a comfortable food for the low people, it is of importance to have them all the year round. For a long time, potatoes in Scotland were confined to the kitchen-garden; and after they were planted in the field, it was not imagined at first that they could be used after the month of December. Of late years they have been found to answer even till April; which has proved a great support to many a poor family, as they are easily cooked, and require neither kiln nor mill. But there is no cause for stopping there. It is easy to preserve them till the next crop: When taken out of the ground, lay in the corner of a barn a quantity that may serve till April, covered from frost with dry straw pressed down: bury the remainder in a hole dug in dry ground, mixed with the husks of dried oats, sand, or the dry leaves of trees, over which build a stack of hay or corn. When the pit is opened for taking out the potatoes, the eyes of what have a tendency to push, must be cut out; and this cargo will serve all the month of June. To
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be still more certain of making the old crop meet the new, the setting a small quantity may be delayed till June, to be taken up at the ordinary time before frost. This cargo, having not arrived to full growth, will not be so ready to push as what are set in April.

If the crop happen to be exhausted before the new crop is ready, the interval may be supplied by the potatoes of the new crop that lie next the surface, to be picked up with the hand; which, far from hurting the crop, will rather improve it,

3. CARROT and PARSNIP.

OF all roots a carrot requires the deepest soil. It ought at least to be a foot deep, all equally good from top to bottom. If such a soil be not in the farm, it may be made artificially by trench-plowing, which brings to the surface what never had any communication with the sun or air. When this new soil is sufficiently improved by a crop or two with dung, it is fit for bearing carrots. Beware of dunging the year when the carrots are sown; for with fresh dung they seldom are free of scabs.

Loam and sand are the only soils proper for that root.

The ground must be prepared with the deepest furrow that can be taken, the sooner after harvest the better; immediately upon the back of which

which a ribbing ought to succeed as directed for barley. At the end of March or beginning of April, which is the time of sowing the seed, the ground must be smoothed with a brake. Sow the seed in drills, with intervals of a foot for hand-hoeing; which is no expensive operation where the crop is confined to an acre or two: but if the quantity of ground be greater, the intervals ought to be three feet, in order for horse-hoeing.

In flat ground without ridges, it may be proper to make parallel furrows with the plough, ten feet from each other, in order to carry off any redundant moisture.

At Parlington in Yorkshire, from the end of September to the first of May, twenty work-horses, four bullocks, and six milk-cows, were fed on the carrots that grew on three acres; and these animals never tasted any other food but a little hay. The milk was excellent: and, over and above, thirty hogs were fattened upon what was left by the other beasts. I have this fact from undoubted authority.

The culture of parsnips is the same with that of carrots.

SECT.

S E C T. III.

PLANTS CULTIVATED FOR LEAVES.

THERE are many garden-plants of this kind. The plants proper for the field are cabbage, red and white; colewort, plain and curled. I know very little difference in the cultivation of these plants. And therefore, to save trouble, I shall confine myself to cabbage.

Cabbage is an interesting article in husbandry, every soil being more or less proper for it. It is easily raised, is subject to few diseases, resists frost more than turnip, is palatable to cattle, and sooner fills the stomach than turnip, carrot, or potatoes.

The season for setting cabbage, depends on the use it is intended for. If intended for feeding in November, December, and January, the plants must be set in March or April, from seed sown the end of July the preceding year. If intended for feeding in March, April, and May, the plants must be set the first week of the preceding July, from seed sown end of February or beginning of March the same year. The late setting of the plants retards their growth; by which means they have a vigorous growth the following spring. And this crop makes an important link in the chain that connects winter and summer green food.

food. Let me observe by the by, that where cabbage for spring-food happens to be neglected, a few acres of rye sown at Michaelmas will supply the want. After the rye is consumed, there is time sufficient to prepare the ground for turnip.

And now to prepare a field for cabbage. Where the plants are to be set in March, the field must be made up, after harvest, in ridges three feet wide. In that form let it lie all winter, to be mellowed with air and frost. In March, take the first opportunity between wet and dry, to lay dung in the furrows. Cover the dung with a plough, which will convert the furrow into a crown, and consequently the crown into a furrow. Set the plants upon the dung, distant from each other three feet. Plant them so as to make a straight line cross the ridges, as well as along the furrows, to which a gardener's line stretched perpendicularly cross the furrows will be requisite. This will set each plant at the distance precisely of three feet from the plants that surround it. The purpose of this accuracy, is to give opportunity for plowing, not only along the ridges, but cross them. This mode is attended with three signal advantages : it saves hand-hoeing, it is a more complete dressing to the soil, and it lays earth neatly round every plant.

If the soil be deep and composed of good earth, a trench-plowing after the preceding crop will

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not be amiss; in which case, the time for dividing the field into three-foot ridges as above, ought to be immediately before the dunging for the plants.

If weeds happen to rise so close to the plants as not to be reached by the plough, it will require very little labour to destroy them with a hand-hoe.

Unless the soil be much infested with annuals, twice plowing after the plants are set will be a sufficient dressing. The first removes the earth from the plants; the next, at the distance of a month or so, lays it back.

Where the plants are to be set in July, the field must be ribbed as directed for barley. It ought to have a slight plowing in June before the planting, in order to loosen the soil, but not so as to bury the surface-earth; after which the three-foot ridges must be formed, and the other particulars carried on as directed above with respect to plants that are to be set in March.

C H A P. VI.

CULTURE OF GRASS.

THE grasses commonly sown for pasture, for hay, or to cut green for cattle, are red clover, white clover, yellow clover, ryegrass, and narrow-

narrow-leaved plantain, commonly called *ribwort*. Among the great variety of grasses, there is little doubt, but that some new sorts may be introduced to advantage. But without meaning to shut out light, I am certain that the grasses mentioned answer completely all useful purposes of husbandry.

Red clover is of all the most proper to be cut green for summer-food. It is a biennial plant when suffered to perfect its seed; but when cut green, it will last three years, and in a dry soil longer. At the same time, the safest course is to let it stand but a single year: if the second year's crop happen to be scanty, it proves, like a bad crop of pease, a great encourager of weeds by the shelter it affords them. Sainfoin and lucern make excellent green food; and, when preserved clean from weeds, they will stand good ten or twelve years, especially in a deep gravel. There they extend their roots very deep, and will grow vigorously in a dry summer, when other plants of shorter roots languish by lack of moisture. But except in such a soil, I venture to declare in favour of red clover; and my reason is, that the expence of sowing it yearly is much less than that of hand-hoeing sainfoin and lucern frequently every year. Sainfoin indeed seems to be the hardier plant. Farmers about Bath sow it in their highest unsheltered grounds; and it endures frost better than clover, or any sort of grain. Like
clover

clover it is sown with barley ; but as the seed is small, much less will suffice than of barley. It is commonly cut but once the first year ; and the first winter, coal-ashes are spread upon it.

Here, as in all other crops, the goodness of red-clover seed is of importance. Chuse plump seed of a purple colour, because it takes on that colour when ripe. It is red when hurt in the drying, and of a faint colour when unripe.

Red clover is luxuriant upon a rich soil, whether clay, loam, or gravel ; it will grow even upon a moor properly cultivated. A wet soil is its only bane ; for there it does not thrive.

To have red clover in perfection, weeds must be extirpated, and stones taken off. The mould ought to be made as fine as harrowing can make it ; and the surface be smoothed with a light roller, if not sufficiently smooth without it. This gives opportunity for distributing the seed evenly ; which must be covered by a small harrow with teeth no larger than of a garden-rake, three inches long, and six inches asunder ; of which there is a draught annexed. In harrowing, the man should walk behind with a rope in his hand fixed to the back part of the harrow, ready to disentangle it from stones, clods, turnip or cabbage roots, which would trail the seed, and displace it.

Nature has not determined any precise depth for the seed of red clover, more than of other seed. It will grow vigorously from two inches deep, and
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it will grow when barely covered. Half an inch I reckon the most advantageous position in clay soil, a whole inch in what is light or loose. It is a vulgar error, that small seed ought to be sparingly covered. Misled by that error, farmers commonly cover their clover-seed with a thorn bush; which not only covers it unequally, but leaves part on the surface to wither in the air.

The proper season for sowing red clover, is from the middle of April to the middle of May. It will spring from the 1st of March to the end of August; but such liberty ought not to be taken except from necessity.

The ordinary manner of sowing, is to hold the seed between the thumb and the two fore fingers. I prefer another manner; which is, to take into the hollow of the hand as much as will serve in walking three or four steps; and to join the fingers to the palm so loosely, as to make many small holes for throwing out the seed. A hand closed so loosely, resembles the rose of a watering pan, which scatters the water through a number of small holes.

There is not a greater mistake in husbandry, than to be sparing of seed. Ideal writers talk of sowing an acre with four pounds. That quantity of seed, say they, will fill an acre with plants as thick as they ought to stand. I admit this rule to be good where grain is the object; but not with respect to grass. Grass-seed cannot be sown

too

too thick : the plants shelter one another : they retain the dew : and they must push upward, having no room laterally. Observe the place where a sack of pease, or of other grain, has been set down for sowing : the seed dropt there accidentally grows more quickly than in the rest of the field sown thin out of hand : I have seen it six inches high, when the rest of the seed scarce appeared above ground. A young plant of clover, or of sainfoin, according to Tull, may be raised to a great size where it has room ; but the field will not produce half the quantity. When red clover is sown for cutting green, there ought not to be less than twenty-four pounds to an acre. A field of clover is seldom too thick : the smaller a stem be, the more palatable to cattle. When too thin, the stems tend to wood.

Red clover is commonly sown with grain ; and the doubt may be, what grain is the most proper. I pronounce in favour of flax ; and I pronounce with confidence from multiplied experience. The soil must be highly cultivated for flax as well as for red clover. The proper season of sowing is the same for both : the leaves of flax being very small, admit of free circulation of air ; and flax being an early crop, is removed so early as to give the clover time for growing. In a rich soil it has grown so fast, as to afford a good cutting that very year. Next to flax, barley is the best companion to clover. The soil must be loose and free
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for barley; and so it ought to be for clover: the season of sowing is the same; and the clover is well established in the ground, before it is overtopped by the barley. At the same time, barley commonly is sooner cut than either oats or wheat. In a word, barley is rather a nurse than a stepmother to clover during its infancy. When clover is sown in spring upon wheat, the soil, which has lain five or six months without being stirred, is an improper bed for it; and the wheat, being in the vigour of growth, overtops it from the beginning. It cannot be sown along with oats, because of the hazard of frost; and when sown as usual among oats three inches high, it is overtopped, and never enjoys free air till the oats are cut. Add, that where oats are sown upon the winter-furrow, the soil is rendered as hard as when under wheat. Red clover is sometimes sown by itself, without other grain; but this method, beside losing a crop, is not salutary; because clover in its infant state requires shelter. The year 1775 confirmed all my experiments about clover. In part of a field, flax was sown with it; in another part, barley; and, in the remainder, it was sown alone. The clover on the first was the best; on the second, inferior; and, on the third, the worst. Yet the barley was sown thin, as it ought to be with grass-seeds, and was but an indifferent crop.

And this leads to the quantity of grain proper to be sown with clover. In a rich soil well pulverized,

verized, a peck of barley on an English acre is all that ought to be ventured ; but there is not much soil in Scotland so rich. Two Linlithgow firlots make the proper quantity for an acre that produces commonly six bolls of barley ; half a firlot for what produces nine bolls. To those who are governed by custom, so small a quantity will be thought ridiculous. Let them only consider, that a rich soil in perfect good order, will from a single seed of barley produce twenty or thirty vigorous stems. People may flatter themselves with the remedy, of cutting barley green for food, if it happen to oppress the clover. This is an excellent remedy in a field of an acre or two ; but the cutting an extensive field for food must be slow ; and while one part is cutting, the clover is smothered in other parts.

The culture of white clover, of yellow clover, of ribwort, of ryegrass, is the same in general with that of red clover. I proceed to their peculiarities. Yellow clover, ribwort, ryegrass, are all of them early plants, blooming the end of April or beginning of May. The two latter are evergreens, and therefore excellent for winter-pasture. Ryegrass is less hurt by frost than any of the clovers, and will thrive in a moister soil : nor in that soil is it much affected by drought. In a rich soil, it grows four feet high : even in the dry summer 1775, it rose to three feet eight inches ; but it had gained that height before the drought

drought came on: These grasses are generally sown with red clover for producing a plentiful crop. The proportion of seed is arbitrary; and there is little danger of too much. When ryegrass is sown for procuring seed, five firlots wheat-measure may be sown on an acre; and for procuring seed of ribwort, forty pounds may be sown. The roots of ryegrass spread horizontally: they bind the soil by their number; and though small, are yet so vigorous as to thrive in hard soil. Red clover has a large tap-root, which cannot penetrate any soil but what is open and free; and the largeness of the root makes the soil still more open and free. Ryegrass, once a great favourite, appears to be discarded in most parts of Britain. But were the management of it well understood, it would be restored to high favour. The common practice has been, to sow it with red clover, and to cut them promiscuously the beginning of June for green food, and a little later for hay. This indeed is the proper season for cutting red clover, because at that time it begins to flower; but as at that time the seed of the ryegrass is approaching to maturity, its growth is at an end for that year, as much as of oats or barley cut after the seed is ripe. Oats or barley cut green before the seed forms, will afford two other cuttings; which also is the case of ryegrass, of yellow clover, and of ribwort. By such management,

all the profit will be drawn that these plants can afford.

When red clover is intended for seed, the ground ought to be cleared of weeds, were it for no other purpose than that the seed cannot otherwise be preserved pure: what weeds escape the plough, ought to be taken out by the hand. In England, when a crop of seed is intended, the clover is always first cut for hay. This I conjecture to be done, as in fruit-trees, to check the growth of the wood, in order to encourage the fruit. This practice will not answer with us, as the seed would often be too late of ripening. Better to eat the clover with sheep till the middle of May, which will give time for the seed to ripen. The first crop of red clover, if not retarded by eating, will not answer so well for seed as the second. The plants grow vigorously; and the leaves cover the seed so as to give little access to the sun and air. For the same reason, pease on rich land grow to the straw, and seldom produce much seed. The seed is ripe when, upon rubbing it between the hands, it parts readily from the husk. Then apply the scythe, spread the crop thin, and turn it carefully. When perfectly dry, take the first opportunity of a hot day for threshing it on boards covered with a coarse sheet. Another way less subject to risk, is to stack the dry hay, and to thresh it the end of April. After the first threshing, expose the husks to the sun, and thresh then

them over and over till no seed remain. Nothing is more efficacious than a hot sun to make the husk part with its seed ; in which view, it may be exposed to the sun by parcels, an hour or two before the flail is applied.

White clover intended for seed, is managed in the same manner. No plant ought to be mixed with ryegrass that is intended for seed. In Scotland, much ryegrass-seed is hurt by transgressing that rule. The seed is ripe when it parts easily from the husk. The yellowness of the stem is another indication of its ripeness ; in which particular it resembles oats, barley, and other culmiferous plants. The best manner to manage a crop of ryegrass for seed, is to bind it loosely in small sheaves, widening them at the bottom to make them stand erect ; as is done with oats in moist weather. In that state, they may stand till sufficiently dry for threshing. By this method, they dry more quickly, and are less hurt by rain, than by close binding and putting the sheaves in shocks like corn. The worst way of all, is, to spread the ryegrass on the moist ground ; for it makes the seed malten. The sheaves, when sufficiently dry, are carried in close carts to where they are to be threshed on a board, as mentioned above for clover. Put the straw in a rick, when a hundred stone or so are threshed. Carry the threshing-board to the place where another rick is intended ; and so on till the whole seed is threshed,
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and the straw ricked. There is necessity for close carts to save the seed, which is apt to drop out in a hot sun: and, as observed above, a hot sun ought always to be chosen for threshing. Carry the seed in sacks to the granary or barn, there to be separated from the husks by a fanner. Spread the seed thin upon a timber floor, and turn it once or twice a day, till perfectly dry. If suffered to take a heat, it is useless for seed.

I shall conclude this chapter with a few observations upon the different endurance of plants. That some plants must be perpetual is evident from the old grass fields seen in every quarter, that are always pastured, and never suffered to go to seed. Even the largest trees have a period of existence; but such grass plants can never wear out, otherways the field would be left bare. Some plants endure but a year; wheat, for example, oats, barley, pease. Their destined purpose is to carry seed, which is complicated within the year, and then they die. Some plants require two years to perfect their seed, which is the case of cabbage. Red clover, yellow clover, ryegrass, carry seed every year; but the first seldom lives above two years, and the others not above seven or eight. White clover is a perennial plant. Like a strawberry it throws out flagellæ or runners from the stem, which take root and become new plants without end. From the roots of others there are stems produced yearly, which do
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not perfect their seed till the second year; after which these stems die and give place to others. Such plants have at the same time not only stems of the second year bearing seed, but recent stems that require another year's growth to carry seed. It is of perennial plants that the green covering of an old pasture field is composed. Some of these are more palatable and nourishing than others; and the old grass field is valuable in proportion to the goodness of plants that grow in it.

But to give all the satisfaction possible on a subject of capital importance in husbandry, I here annex a list of perennial grasses, including not only what endure for ever, but what are very long lived. Every pasture field in Scotland from 5s. to L. 5 per acre, is composed of some of the sixteen following grasses.

1. *Poa annua*. Suffolk grass.

This grass requires a mild climate more than any other gramineous plant we have. It perishes by the severity of the Swedish winter; and upon that account is classed among annuals by Linnæus. But though it is an annual in Sweden, it is perennial in Scotland.

2. *Poa trivialis*. Common meadow-grass.

3. *Poa pratensis*. Great meadow-grass.

4. *Poa angustifolia*. Narrow-leaved meadow-grass.

5. *Lolium*

5. *Lolium perenne*. Rye-grass.
6. *Avena flavescens*. Yellow oat-grass.

The most valuable pastures both in England and Scotland, are mostly formed of these six species, which never grow but in rich soil. They affect old manured land, and prevail in our croft lands; but are never to be seen in what we call out-field, nor will they grow in it.

7. *Alopecurus pratensis*. Meadow fox tail.
8. *Anthoxanthum odoratum*. Vernal grass.
9. *Cynosurus cristatus*. Crested dogs tail.
10. *Agrostis capillaris*. Fine bent grass.

These four species, though often mixed with the former in rich pasture, can take up with a meaner soil. They compose the chief part of all the out-field pasture, that is, of all the pasture in Scotland. The tenth species is the most prevalent; and forms more of the herbage of Scotland than any other plant.

11. *Phleum pratense*. Meadow cats tail.
12. *Holcus lanatus*. Meadow soft-grass.
13. *Dactylis glomerata*. Orchard-grass.
14. *Bromus secalinus*. Goose-grass.

These four are tall rank grasses, that are postponed by cattle when green, where they can get any of the former. They afford good hay however, and give a great crop.

15. *Festuca*

15. *Festuca ovina*. Sheeps fescue.
16. *Festuca duriuscula*. Hard fescue.

These two species form our best sheep pasture ; but are of too diminutive a growth for the scythe, and not a subject of culture.

All these grasses propagate powerfully by the roots as well as by seed. Their manner of growth by the roots, as above hinted, is in two different ways. The first by suckers, which rise successively from the present plant ; and the grasses that grow in this way, form large tufts of a round figure. The second is by runners, which shoot forth on all sides of the plant. These are the grasses which form the most close uniform sward, and the best pasture. Both kinds are perennial ; and I may say perpetual ; for in their proper soil they will grow for ever, without being renewed by seed.

Ribwort and white clover, are not in this list ; because they are not considered as grasses by the learned in botany. But as they are perennial, propagating both by seeds and roots, they are capital articles in old pasture. Ryegrass in its natural soil is a perennial : in that soil, it propagates both by seeds and roots, and subsists in vigour where it never was sown by art. In a soil less natural to it, the seeds sown may produce a few good crops ; but it will not renovate itself either by seeds or roots. This is the case in most fields

fields of cultivated ryegrass, especially in a wet or clay soil, or where other predominant grasses prevail. Even white clover will decay, where it is raised in a soil that is not natural to it.

CHAP. VII.

ROTATION OF CROPS.

NO branch of husbandry requires more skill and sagacity than a proper rotation of crops, so as to keep the ground always in heart, and yet to draw out of it the greatest profit possible. A horse is purchased for labour; and it is the purchaser's intention to make the most of him. He is well fed, and wrought according to his strength: to overwork him, is to render him useless. Precisely similar is land. Profit is the farmer's object; but he knows, that to run out his farm by indiscreet cropping, is not the way to make profit. Some plants rob the soil, others are gentle to it: some bind, others loosen. The nice point is, to intermix crops, so as to make the greatest profit consistently with keeping the soil in order. In that view, the nature of the plants employed in husbandry, must be accurately examined.

The difference between culmiferous and leguminous plants, is occasionally mentioned above*.

With

* Chap. 5.

With respect to the present subject, a narrower inspection is necessary. Culmiferous plants, having small leaves and few in number, depend mostly on the soil for nourishment, and little on the air. During the ripening of the seed, they draw probably their whole nourishment from the soil; as the leaves by this time, being dry and withered, must have lost their power of drawing nourishment from the air. Now, as culmiferous plants are chiefly cultivated for seed, and are not cut down till the seed be fully ripe, they may be pronounced all of them to be robbers, some more some less. But such plants, while young, are all leaves; and in that state draw most of their nourishment from the air. Hence it is, that where cut green for food to cattle, a culmiferous crop is far from being a robber. A hay-crop accordingly, even where it consists mostly of ryegrass, is not a robber, provided it be cut before the seed is formed; which at any rate it ought to be, if one will have hay in perfection. And the foggage, excluding frost by covering the ground, keeps the roots warm. A leguminous plant, by its broad leaves, draws much of its nourishment from the air. A cabbage, which has very broad leaves and a multitude of them, owes its growth more to the air than to the soil. One fact is certain, that a cabbage cut and hung up in a damp place, preserves its verdure longer than other plants. At the same time, a seed is that part of

a plant which requires the most nourishment; and for that nourishment a culmiferous plant must be indebted entirely to the soil. A leguminous crop, on the contrary, when cut green for food, must be very gentle to the ground. Pease and beans are leguminous plants; but being cultivated for seed, they seem to occupy a middle station: their seed makes them more severe than other leguminous crops cut green: their leaves, which grow till reaping, make them less severe than a culmiferous plant left to ripen.

These plants are distinguished no less remarkably by the following circumstance. All the seeds of a culmiferous plant ripen at the same time. As soon as they begin to form, the plant becomes stationary, the leaves wither, the roots cease to push, and the plant, when cut down, is blanchd and sapless. The seeds of a leguminous plant are formed successively: flowers and fruit appear at the same time in different parts of the plant. This plant accordingly is continually growing, and pushing its roots. Hence the value of bean or pease straw above that of wheat or oats: the latter is withered and dry when the crop is cut; the former, green and succulent. The difference therefore with respect to the soil between a culmiferous and leguminous crop, is great. The latter, growing till cut down, keeps the ground in constant motion, and leaves it to the plough loose and mellow. The former gives
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over growing long before reaping, and the ground, by want of motion, turns compact and hard. Nor is this all. Dew falling on a culmiferous crop after the ground begins to harden, rests on the surface, and is sucked up by the next sun. Dew that falls on a leguminous crop, is shaded from the sun by the broad leaves, and sinks at leisure into the ground. The ground accordingly after a culmiferous crop, is not only hard but dry : after a leguminous crop, it is not only loose, but soft and unctuous.

Of all culmiferous plants, wheat is the most severe, by the long time it occupies the ground without admitting a plough. And as the grain is heavier than that of barley or oats, it probably requires more nourishment than either. Spring-wheat is creeping into use : if it succeed, it will probably be not much more severe than other culmiferous plants. It is observed above, that as pease and beans draw part of their nourishment from the air by their green leaves while allowed to stand, they draw the less from the ground ; and by their constant growing they leave it in good condition for subsequent crops. In both respects they are preferable to any culmiferous crop.

Culmiferous crops, as observed above, are not robbers when cut green : the soil, far from hardening, is kept in constant motion by the pushing
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ing of the roots, and is more tender than if it had been left at rest without bearing any crop.

Bulbous-rooted plants are above all operative in dividing and pulverising the soil. Potato-roots grow six, eight, or ten, inches under the surface; and, by their size and number, they divide and pulverize the soil better than can be done by the plough; consequently, whatever be the natural colour of the soil, it is black when a potato-crop is taken up. The potato, however, with respect to its quality of dividing the soil, must yield to a carrot or parsnip; which are large roots, and pierce often to the depth of eighteen inches. The turnip, by its tap-root, divides the soil more than can be done by a fibrous-rooted plant; but as its bulbous root grows mostly above ground, it divides the soil less than the potato, the carrot, or the parsnip. Red clover, in that respect, may be put in the same class with turnip.

Whether potatoes or turnip be the more gentle crop, appears a puzzling question. The former bears seed, and probably draws more nourishment from the soil, than the latter when cut green. On the other hand, potatoes divide the soil more than turnip, and leave it more loose and friable. It appears no less puzzling, to determine between cabbage and turnip: the former draws more of its nourishment from the air, the latter leaves the soil more free and open.

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Here are a number of facts : What is the result of the whole ? Clearly what follows. Culmiferous plants are robbers ; some more, some less : they at the same time bind the soil ; some more, some less. Leguminous plants in both respects are opposite : if any of them rob the soil, it is in a very slight degree ; and all of them without exception loosen the soil. A culmiferous crop, however, is generally the more profitable : but few soils can long bear the burden of such crops, unless relieved by interjected leguminous crops. These, on the other hand, without a mixture of culmiferous crops, would soon render the soil too loose.

These preliminaries will carry the farmer some length in directing a proper rotation of crops. Where dung, lime, or other manure, can be procured in plenty to recruit the soil after severe cropping, I know no rotation more proper or profitable in a strong soil, than wheat, pease or beans, barley, oats, fallow. The whole farm may be brought under this rotation, except so far as hay is wanted. But as such command of manure is rare, it is of more importance to determine what should be the rotation, where no manure can be procured but the dung collected in the farm. Considering that culmiferous crops are the more profitable in rich land, it would be proper to make them more frequent than the other kind. But as there are few soils in Scotland

land that will admit such frequent culmiferous crops without suffering, it may be laid down as a general rule, that alternate crops, culmiferous and leguminous, ought to form the rotation. Nor are there many soils that will stand good, even with this favourable rotation, unless relieved from time to time by pasturing a few years. If such extended rotation be artfully carried on, I take it for granted, that crops without end may be obtained in a tolerable good soil, without any manure but what is produced in the farm.

Having discussed the nature of plants as far as rotation of crops is concerned, the nature of the soil comes next under consideration. It is scarce necessary to be mentioned, being known to every farmer, that clay answers best for wheat, moist clay for beans, loam for barley and pease, light soil for turnip, sandy soil for rye and buck wheat; and that oats thrive better in coarse soil than any other grain. Now, in directing a rotation, it is not sufficient that a culmiferous crop be always succeeded by a leguminous: attention must be also given, that no crop be introduced that is unfit for the soil. Wheat, being a great binder, requires more than any other crop, a leguminous crop to follow. But every such crop is not proper: potatoes are the greatest openers of soil; but they are improper in a wheat-soil. Neither will turnip answer, because they require a light soil. A very loose soil, after a crop of rye requires

quires ryegrass to bind it, or the treading of cattle in pasturing: but to bind the soil wheat must not be ventured; for it succeeds ill in loose soil.

Another consideration of moment in directing the rotation, is to avoid crops that encourage weeds. Pease is the fittest of all crops for succeeding to wheat, because it renders the ground loose and mellow, and the same soil agrees with both. But beware of pease, unless the soil be left by the wheat perfectly free of weeds; because pease, if not an extraordinary crop, foster weeds. Barley may be ventured after wheat, if the farmer be unwilling to lose a crop. It is indeed a robber; better however any crop than run the hazard of poisoning the soil with weeds. But to prevent the necessity of barley after wheat, the land ought to be fallowed before the wheat: it cleans the ground thoroughly, and makes pease a secure crop after wheat. And after a good crop of pease, barley never fails. A horse-hoed crop of turnip is equal to a fallow for rooting out weeds; but turnip does not suit land that is proper for wheat. Cabbage does well in wheat-soil; and a horse-hoed crop of cabbage, which eradicates weeds, is a good preparation for spring-wheat. A crop of beans diligently hand-hoed is in that view little inferior*. As red clover

* Spring wheat will not answer in strong clay, as it has not sufficient time to ripen.

clover requires the ground to be perfectly clean, a good crop of it ensures wheat, and next pease. In loam, a drilled crop of turnip or potatoes prepares the ground, equal to a fallow, for the same succession.

Another rule is, to avoid a frequent repetition of the same species; for to produce good crops, change of species is no less necessary than change of seed. The same species returning every second or third year, will infallibly degenerate, and be a scanty crop. This is remarkably the case of red clover. Nor will our fields bear pleasantly perpetual crops of wheat after fallow, which is the practice of some English farmers.

Hitherto of rotation in the same field. I add one rule concerning rotation in different fields; which is, to avoid crowding crops one after another in point of time; but to chuse such as admit intervals sufficient for leisurely dressing, which gives opportunity to manage all with the same hands, and with the same cattle; for example, beans in January or February, pease and oats in March, barley and potatoes in April, turnip in June or July, wheat and rye in October.

For illustrating the foregoing rules, a few instances of exceptionable rotations, will not be thought amiss. The following is an usual rotation in Norfolk. First, wheat after red clover. Second, barley. Third, turnip. Fourth, barley with red clover. Fifth, clover cut for hay. Sixth, a second

second year's crop of clover commonly pastured. Dung is given to the wheat and turnip. Against this rotation several objections lie. Barley after wheat is improper. The two crops of barley are too near together. The second crop of clover must be very bad, if pasturing be the best way of consuming it; and if bad, it is a great encourager of weeds. But the strongest objection is, that red clover repeated so frequently in the same field cannot fail to degenerate; and of this the Norfolk farmers begin to be sensible. Salton in East Lothian is a clay soil; and the rotation there is, wheat after fallow and dung. Second, barley after two plowings; the one before winter, the other immediately before the seed is sown. Third, oats. Fourth, pease. Fifth, barley. Sixth, oats: and then fallow. This rotation consists chiefly of robbing crops. Pease are the only leguminous crop, which even with the fallow is not sufficient to loosen a stiff soil. But the soil is good, which in some measure hides the badness of the rotation. About Seaton, and all the way from Preston to Gossford, the ground is still more severely handled: wheat after fallow and dung, barley, oats, pease, wheat, barley, oats, and then another fallow. The soil is excellent; and it ought indeed to be so, to support many rounds of such cropping.

But let not our wonder be confined to this narrow spot; for what better do we find in the great-

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est part of this county? In the parishes of Trarant, Aberlady, Dirleton, Northberwick, and Athelstonefoord, the following rotations were formerly universal, and to this day are much more frequent than any other mode.

1. After fallow with dung, wheat, barley, oats, pease and beans, barley, oats, wheat.

2. After fallow and dung, barley, oats, pease and beans, wheat, barley, oats, pease, wheat.

3. After fallow and dung, wheat, oats, pease, barley, oats, wheat.

4. After fallow and dung, barley, oats, beans, wheat, pease, barley, oats.

East Lothian, time out of mind, has been famous for superior skill in agriculture; and yet, to seek for instruction there, one would be greatly misled. That county, for the richness of its crops, is more indebted to the fertility of its soil, than to the skill of its farmers. What pity it is, that so fine a country should be possessed by men so little grateful to nature for her bounties! But their ingratitude is not suffered to pass with impunity. Every farmer complains that his crops are not such as they have been: the decay is visible: but the cause, however obvious, is not manifest to every one. Some few who justly ascribe the decay to severity of cropping, have ventured upon some alterations; but so imperfectly, from the prepossession of former practice, as to have made no considerable progress. The following rotations,
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held to be improvements upon the former practice, will justify this observation.

1. After fallow without dung, barley, clover. Dung laid on the clover-stubble, and after a single plowing, wheat, barley, oats.

2. After fallow with dung, wheat, barley, pease, wheat.

3. After fallow with dung, wheat, beans hand-hoed, wheat, pease and beans drilled, wheat with dung, barley, clover. Dung laid on the clover-stubble. Spring-wheat, one furrow before winter, and one before sowing. Turnip broadcast, barley and grafs-seeds for pasture.

4. After fallow with dung, wheat, barley with clover-feed. Clover made hay two years. After the second year's crop, fallow and dung for wheat, barley, oats, pease, oats or wheat, turnip with dung, barley, pease, barley, oats.

5. Potatoes dunged, wheat, pease, barley and grafs-seeds.

6. After fallow with dung, wheat, oats, pease or clover, wheat, oats, clover. The clover-stubble dunged for barley, oats, pease after two furrows, wheat after one furrow.

7. Lincoln barley upon ground opened from pasture grafs, pease, wheat, turnip, barley, clover. The stubble dunged for wheat, beans, barley, oats.

8. After fallow and dung, barley, clover red and white for hay, pasture seven years, oats, pease, wheat, barley, oats.

9. Turnip

9. Turnip after lime and dung. Barley, with which white clover, yellow clover, ryegrass, and ribwort, are sown. Pastured with sheep seven years, broken up for oats, drilled beans, barley, oats.

These rotations are far from being orthodox; but it is good to be convinced of an error: and when once a reformation is fairly begun, it is to be hoped, that the farmers in the best county of Scotland, will at last settle in such a rotation of crops, as will prove no less beneficial to themselves than to their landlords.

After such severe censure I would gladly make some apology for the East-Lothian farmers. In Young's several Tours through the best counties of England, examples are found without end of rotations no less exceptionable than many of those mentioned.

Where a field is laid down for pasture in order to be recruited, it is commonly left in that state many years; for it is the universal opinion, that the longer it lies, the richer it becomes for bearing corn. This I believe to be true; but in order to determine the mode of cropping, the important point is, what upon the whole is the most profitable rotation; not what may produce luxuriant crops at a distant period. Upon that point, I have no hesitation to affirm, that the farmer who keeps a field in pasture beyond a certain time, loses every year considerably; and that a few luxuriant

xuriant crops of corn, after twenty years of pasture, and still more after thirty, will not make up the loss. The novelty of this proposition will discredit it with the generality; but as the subject is of capital importance in the management of a farm, I must notwithstanding hope for a patient hearing. Grass-seeds intended for hay, produce the weightiest crop at first: were hay to be taken many years successively without manure, the crops would turn exceeding scanty. To prevent loss, the farmer confines himself to two or three crops; and then surrenders the field to pasture. The same happens where a field is laid down with pasture-grasses: the first year's pasture is more plentiful than any of the succeeding. For a proof of which, a field newly laid down for pasture will draw a greater rent, than after being pastured seven or eight years; if I should say double, it would not be far from the truth. Nor is it difficult to assign a cause for the degeneracy. Of the plants cultivated for hay and pasture, few are long lived. Red clover, the chief of them, is only a biennial; and neither ryegrass nor yellow clover, lasts above seven or eight years. They push vigorous stems at first, which every year turn weaker and weaker. In the mean time, the pasture is scanty till natural grasses spring up to supply what are gone; which seldom equal sown grasses for feeding. The precise time when grass ought to yield to corn, depends greatly on the nature

nature of the soil. Our best director is practice. I will only venture to suggest, that clay soil may, without loss, be kept in pasture much longer than gravelly or light soil. The former being retentive of moisture, preserves grass in vigour, even during the heat of summer : grass in the latter soon withers by lack of moisture. This is providential : a light or gravelly soil can be cultivated almost in any season : clay is extremely ticklish ; and where successfully laid down for pasture, ought not rashly to be taken up again ; especially as it maintains more cattle, and consequently receives more dung, than the other kind. It is extremely true, that a greater number of corn-crops may be successfully taken upon a field that has been long in pasture, than when pastured but a few years. But will the additional crops of corn overbalance the mean returns from older grass ? Far from it. Why not then restore a field to corn as soon as the pasture begins to fail ? The corn will quadruple the value of the pasture : the labour indeed and expence is greater ; but they will be amply recompensed by the profit.

If the lesson here inculcated be solidly founded, it must produce a great change in the management of a farm. Pasture-grass, while young, maintains many animals ; and the field is greatly recruited by what they drop : it is even recruited by hay-crops, provided the grass be cut before feeding. But the field ought to be taken up for corn

corn when the pasture begins to fail : and after a few crops, it ought to be laid down again with grafs-seeds. Seduced by a chimerical notion, that a field, by frequent corn-crops, is fatigued and requires rest, like a labouring man or animal, careful farmers give long rest to their fields by pasture, never adverting that it affords little profit. Pity it is, that by a chimerical notion they should be tantalized, to neglect good crops within their reach. It ought to be their study to improve the soil, by making it free and also retentive of moisture. If they accomplish these ends, they need not be afraid of exhausting the soil by cropping *

Against frequent changes from grafs to corn, what follows has the appearance of an objection, that much labour is requisite to convert old pasture land to good tilth, reiterated plowing and harrowing, frequent brakeing, and carts after all to remove the grafs-knots. Long experience encourages me to recommend trench-plowing as the most effectual, cheapest, and most expeditious method for operating this conversion. With a paring-plough the surface is laid at the bottom of the furrow with the grassy side under ; and covered

* As vegetable and animal food are equally natural to man, it is admirable in Providence, to adjust the soil we tread on so happily to our nature, as to yield more food by a rotation of corn and grafs crops, than if it were confined to either.

covered with three or four inches of fresh mould, raised by another plough going in the same track. This being done before winter, the frost preparation makes the soil a fine bed for the seed when the season opens. Where the soil is tolerably tender, trench-plowing never fails to lay the surface smooth : the seed is all laid at an equal depth and springs up equally. Much seed also is saved, which in ordinary plowing is buried by the roughness of the surface. There is another advantage above all the rest, especially in light soil, that the moisture is retained by the grass at the bottom of the furrow, and gives great nourishment to the young plants. Old grass is generally acknowledged to be the most nourishing, to produce finer meat, and richer milk and butter, than when it was young. And it will be objected, that the farmer is deprived of that benefit by the rotation above recommended. Supposing old grass to be a benefit with respect to profit, the farmer's chief object ; he pays a very high price for old grass by abstaining from the profit of such rotation. I yield, however, that where in a farm there happens to be very old grass of a good quality, the most prudent way is to let it remain as it is. And with respect to gentlemen of fortune, it may be commendable luxury to set apart for old grass a field adjacent to the mansion-house, never to be converted into corn. But the quality of the grass ought to be good ; otherways the field will contribute

tribute to luxury as little as to profit. A soil has no choice in its plants; but fosters indifferently every kind palatable or unpalatable. In old pasture, nothing is more common than cattle every now and then putting out at the side of the mouth certain grasses; an evident proof that they are unpalatable. This never is seen in new pasture from choice plants. Therefore, to have old pasture in perfection, let the field be stored with white clover, ribwort, and other succulent perennial plants, so thick sown as to exclude all other plants. Unless where this precaution has been used, it is a great chance to find old pasture that will give absolute satisfaction.

Where a farmer has access to no manure but what is his own production, the case under consideration, there are various rotations of crops, all of them good, though perhaps not equally so. I shall begin with two examples, one in clay, and one in free soil, each of the farms ninety acres. Six acres are to be inclosed for a kitchen-garden, in which there must be annually a crop of red clover, for summer-food to the working cattle. As there are annually twelve acres in hay, and twelve in pasture, a single plough with good cattle will be sufficient to command the remaining sixty acres.

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Rotation in a clay soil.

Inclot.	1775.	1776.	1777.	1778.	1779.	1780.
1.	Fallow.	Wheat.	Pease.	Barley.	Hay.	Oats.
2.	Wheat.	Pease.	Barley.	Hay.	Oats.	Fallow.
3.	Pease.	Barley.	Hay.	Oats.	Fallow.	Wheat.
4.	Barley.	Hay.	Oats.	Fallow.	Wheat.	Pease.
5.	Hay.	Oats.	Fallow.	Wheat.	Pease.	Barley.
6.	Oats.	Fallow.	Wheat.	Pease.	Barley.	Hay.
7.	Pasture.	Pasture.	Pasture.	Pasture.	Pasture.	Pasture.

When the rotation is completed, the seventh inclosure having been six years in pasture, is ready to be taken up for a rotation of crops, which begins with oats in the year 1781, and proceeds as in the sixth inclosure. In the same year 1781, the fifth inclosure is made pasture; for which it is prepared, by sowing pasture grass-seeds with the barley of the year 1780. And in this manner may the rotation be carried on without end. Here the labour is equally distributed; and there is no hurry nor confusion. But the chief property of this rotation is, that two culmiferous or white-corn crops, are never found together: by a due mixture of crops, the soil is preserved

preserved in good heart without any adventitious manure. At the same time, the land is always producing plentiful crops: neither hay nor pasture get time to degenerate. The whole dung is laid upon the fallow.

Every farm that takes a grass crop into the rotation must be inclosed, which is peculiarly necessary in a clay soil, as nothing is more hurtful to clay than poaching.

Rotation in a free soil.

Incl ^{of} .	1775.	1776.	1777.	1778.	1779.	1780.
1.	Turnip.	Barley.	Hay.	Oats.	Fallow.	Wheat.
2.	Barley.	Hay.	Oats.	Fallow.	Wheat.	Turnip.
3.	Hay.	Oats.	Fallow.	Wheat.	Turnip.	Barley.
4.	Oats.	Fallow.	Wheat.	Turnip.	Barley.	Hay.
5.	Fallow.	Wheat.	Turnip.	Barley.	Hay.	Oats.
6.	Wheat.	Turnip.	Barley.	Hay.	Oats.	Fallow.
7.	Pasture.	Pasture.	Pasture.	Pasture.	Pasture.	Pasture.

For the next rotation, the seventh inclosure is taken up for corn, beginning with an oat-crop, and proceeding in the order of the fourth inclosure; in place of which, the third inclosure is laid down for pasture, by sowing pasture-grasses with

with the last crop in that inclosure, being barley. This rotation has all the advantages of the former. Here the dung is employed on the turnip-crop.

We proceed to consider what rotation is proper for carse clay. The farm I propose consists of seventy-three acres. Nine are to be inclosed for a kitchen-garden, affording plenty of red clover to be cut green for the farm-cattle. The remaining sixty-four acres are divided into four inclosures, sixteen acres each, to be cropped as in the following table.

Inclof.	1775.	1776.	1777.	1778.
1.	Beans.	Barley.	Hay.	Oats.
2.	Barley.	Hay.	Oats.	Beans.
3.	Hay.	Oats.	Beans.	Barley.
4.	Oats.	Beans.	Barley.	Hay.

Here the dung ought to be applied to the barley.

Many other rotations may be contrived, keeping to the rules above laid down. For a clay soil, fallow, wheat, pease and beans, barley, cabbage, oats. Here dung must be given both to the wheat and cabbage. For free soil, drilled turnip, barley, red clover, wheat upon a single furrow,

furrow, drilled potatoes, oats. Both the turnip and potatoes must have dung. Another for free soil: turnip drilled and dunged, barley, red clover, wheat on a single furrow with dung, pease, barley, potatoes, oats. The following rotation has proved successful in a soil proper for wheat.

1. Oats with red clover after fallow, without dung. 2. Hay. The clover-stubble dunged, and wheat sown end of October with a single furrow. 3. Wheat. 4. Pease. 5. Barley. Fallow again. Oats are taken the first crop to save the dung for the wheat. Oats always thrive on a fallow, though without dung; which is not the case of barley. But barley seldom fails after pease. In strong clay soil, the following rotation answers. 1. Wheat after fallow and dung. 2. Beans sown under furrow as early as possible. Above the beans, sow pease end of March, half a boll per acre, and harrow them in. The two grains will ripen at the same time. 3. Oats or barley on a winter-furrow with grass-seeds. 4. Hay for one year or two; the second growth pastured. Lay what dung can be spared on the hay-stubble, and sow wheat with a single furrow. 5. Wheat. 6. Beans or pease. 7. Oats. Fallow again.

C H A P. VIII.

REAPING CORN AND HAY CROPS, AND
STORING THEM FOR USE.

CULMIFEROUS plants are ripe when the stem is totally white: they are not fully ripe if any green streaks remain. Some farmers are of opinion, that wheat ought to be cut before it is fully ripe. Their reasons are, first, that ripe wheat is apt to shake; and, next, that the flour is not so good. With respect to the last, it is contrary to nature, that any seed can be better in an unripe state, than when brought to perfection: nor will it be found so upon trial. With respect to the first, wheat, at the point of perfection, is not more apt to shake than for some days before: the husk begins not to open till after the seed is fully ripe; and then the suffering the crop to stand becomes ticklish: after the minute of ripening, it should be cut down in an instant, if possible.

This leads to the persons that are commonly engaged to cut down corn. In this country, the universal practice was, to provide a number of hands, in proportion to the extent of the crop, without regard to the time of ripening. By this method, the reapers were often idle for want of work; and what is much worse, they had often
more

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more work than they could overtake, and ripe fields were laid open to shaking winds. The Lothians have long enjoyed weekly markets for reapers, where a farmer can provide himself with the number he wants; and this practice is creeping into neighbouring shires. Where there is no opportunity of such markets, ought not neighbouring farmers to agree in borrowing and lending their reapers? The advantage is obvious; and yet I believe it is seldom practised.

One should imagine, that a caveat against cutting corn when wet, is unnecessary; yet from the impatience of farmers to prevent shaking, no caveat is more so. Why do they not consider, that corn standing, dries in half a day, when in a close sheaf, the weather must be favourable if it dry in a month? in moist weather it will never dry.

With respect to the manner of cutting, I must premise, that barley is of all the most difficult grain to be dried for keeping. Having no husk, rain has easy access; and it has a tendency to malt when wet. Where the ground is properly smoothed by rolling, I am clear for cutting it down with the scythe. This manner being more expeditious than the sickle, removes it sooner from the danger of wind; and gives a third more straw, which is a capital article for dung, where a farm is at a distance from other manure. I except only corn that has lodged; for there the sickle is more convenient than the scythe. As it
ought

ought to be dry when cut, bind it up directly: if allowed to lie any time in the swath, it is apt to be discoloured.

Barley sown with grass-seeds, red clover especially, requires a different management. Where the grass is cut along with it, the difficulty is great of getting it so dry as to be ventured in a stack. The cunning way is, to cut the barley with a sickle above the clover, so as that nothing but clean barley is bound up. Cut with a scythe the stubble and grass: they make excellent winter-food. The same method is applicable to oats; with this only difference, that when the field is exposed to the south-west wind, it is less necessary to bind immediately after mowing. As wheat commonly grows higher than any other grain, it is difficult to manage it with the scythe; for which reason the sickle is preferred in England. Pease and beans grow so irregularly, as to make the sickle necessary.

The best way for drying pease, is to keep separate the handfuls that are cut: though in this way they wet easily, they dry as soon. In the common way of heaping pease together for composing a sheaf, they wet as easily, and dry not near so soon. With respect to beans, the top of the handful last cut, ought to be laid on the bottom of the former; which gives ready access to wind. By this method, pease and beans are ready for the stack in half the ordinary time.

The

The size of the sheaves ought to be regarded. A sheaf commonly is made as large as can be contained in two lengths of the corn made into a rope. To save frequent tying, the binder presses it down with his knee, and binds it so hard as totally to exclude air. If there be any moisture in the crop, which seldom fails, a process of fermentation and putrefaction commences in the sheaf; which is perfected in the stack, to the destruction both of corn and straw. How barbarous and stupid is it, to make the size of a sheaf depend on the height of the plants! By that rule, a wheat-sheaf is commonly so weighty, as to be unmanageable by ordinary arms: it requires an effort to move it, that frequently bursts the knot, and occasions loss of grain, beside the trouble of a second tying. I have long practised the following method with success. My sheaves are never larger than to be contained in one length of the plant, cut close to the ground: I admit no exception if the plants be above eighteen inches high. The binder's arm compresses the sheaf sufficiently, without need of his knee. The additional hands that this way of binding may require, are not to be regarded, compared with the advantage of drying soon. Corn thus managed may be ready for the stack in a week: it seldom in the ordinary way requires less than a fortnight, and frequently longer. Of a small sheaf compressed by the arm only, the air pervades every part;

nor is it so apt to be unloosed as a large sheaf, however firmly bound. The ordinary practice of directing the shocks to the south-west for resisting the force of that wind, must be approved; but I cannot approve the placing on each side five large sheaves, such as require for a binding two lengths of the corn; which make so long a line as to be but imperfectly covered with the two head sheaves. There ought to be no more but four sheaves on a side. Five of my small sheaves, occupying still less space than four of the ordinary sort, are covered sufficiently by the two head sheaves; and for that reason, I follow the ordinary practice of twelve sheaves to a shock.

Every article is of importance that hastens the operation, in a country like Scotland, subjected to unequal harvest-weather. For carrying corn from the field to the stack-yard, a sledge is a very awkward machine: many hands are required, and little progress made. Waggon and large carts are little less dilatory, as they must stand in the yard till unloaded sheaf by sheaf. My way is, to use long carts moveable upon the axle, so as at once to throw the whole load on the ground; which is forked up to the stack by a man appointed for that purpose. By this method, two carts will do the work of four or five.

It will not be easy to convince me, that building round stacks in the yard is not preferable to housing the corn. Here it is shut up from the
air;

air; and it must be exceedingly dry, if it contract not a mustiness, which is the first step to putrefaction. Let me add another circumstance, which would make a figure were it detached from that now mentioned. In the yard, a stack is preserved from rats and mice by being set on a pedestal: no method has hitherto been invented, for preserving corn in a house from such destructive vermin*. The proper manner of building, is to make every sheaf incline downward from its top to its bottom. Where the sheaves are laid horizontally, the stack will take in rain both above and below. The best form of a stack is that of a cone placed on a cylinder; and the top of the cone should be formed with three sheaves drawn to a point. If the upper part of the cylinder be a little wider than the under, so much the better.

The

* Magazines for corn have been much extolled both in France and in England. But beside the immoderate expence, they are very prejudicial to the commerce of corn. A farmer who has his stacks upon pedestals, waits patiently for a market; and thereby the price of corn is regulated by the demand. The proprietors of magazines, who are few in number compared with farmers, can by combination fix the price above or below the demand as it suits their interest; which is hurtful to buyers; and still more to poor tenants, who, if it were not for magazines, would draw high prices in case of a scanty crop. This would be a great discouragement to agriculture, and make the farmer relax from his industry. Many would abandon the business altogether.

The delaying to cover a stack for two or three weeks, though common, is however wonderfully absurd; for if much rain fall in the interim, it is beyond the power of wind to dry the stack. Vegetation, begun in the external parts, shuts out the air from the internal; and to prevent a total putrefaction, the stack must be thrown down, and exposed to the air, every sheaf. In order to have a stack covered the moment it is finished, straw and ropes ought to be ready; and the covering ought to be so thick as to be proof against rain.

Scotland is subject not only to floods of rain, but to high winds. Good covering guards against the former, and ropes artfully applied guards against the latter. I will answer for the following mode. Take a hay-rope well twisted, and surround the stack with it, two feet or so below the top. Surround the stack with another such rope immediately below the easing. Connect these two with ropes in an up and down position, distant from each other at the easing about five or six feet. Then surround the stack with other circular ropes parallel to the two first mentioned, giving them a twist round every one of those that lie up and down, by which the whole will be connected together in a network. What remains is, to finish the two feet at the top of the stack. Let it be covered with bunches of straw laid regularly up and down; the low part

part to be put under the circular rope first mentioned, which will keep it fast, and the high part be bound by a small rope artfully twisted, commonly called *the crown of the stack*. This method is preferable to the common way of laying long ropes over the top of the stack, and tying them to the belting-rope; which flattens the top, and makes it take in rain. A stack covered in the way here described, will stand two years secure both against wind and rain; a notable advantage in this variable climate*. So much for corn. Now for hay.

The

* A granery for holding the whole product of a farm, must be a very expensive building, and a severe tax upon husbandry. I have heard it computed, that laying aside towns and villages, the English barns have cost more money than all their other houses together. I can easily conceive an indolent practice supported long by custom against the clearest light. But expensive works are seldom attempted but from necessity; and I cannot easily conceive what at first produced that expensive mode of preserving corn and straw together, when both can be preserved in good condition by stacks in the yard; and at any rate, when it is much less expensive to store up the grain separated from the straw. There was a time not long past, when the most inventive heads in England and France, were employed upon contriving granaries for corn, but without success. I have no difficulty to pronounce, that a stack built as above directed, and set upon a pedestal, is the best way for preserving corn, and that for years, far beyond the most complete granary that ever was contrived, even laying aside the expence of building and of management.

The great aim in making hay is, to preserve as much of the sap as possible. All agree in this; and yet differ widely in the means of making that aim effectual. To describe all the different means, might be profitable to the bookseller; but the reader would lose patience, and gather no instruction. I shall therefore confine myself to what I think the best. A crop of ryegrass and yellow clover ought to be spread as cut. Let it lie a day or two; and in the forenoon after the dew is evaporated, rake it into a number of parallel rows along the field, termed *wind-rows*, for the convenience of putting it up into small cocks. After turning the rows once and again, make small cocks weighing a stone or two. At the distance of two days or so, put two cocks into one, observing always to mix the tops and bottoms together, and to take a new place for each cock, that the least damage possible may be done to the grass. Proceed in putting two cocks into one, till sufficiently dry for tramp-ricks of 100 stone each. The easiest way of erecting tramp-ricks, is to found a rick in the middle of the row of cocks that are to compose it. The cocks may be carried to the rick by two persons joining arms together. When all the cocks are thus carried to the rick within the distance of forty yards or so, the rest of the cocks will be more expeditiously carried to the rick, by a rope wound about them and dragged by a horse. Two ropes
are

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are sufficient to secure the ricks from wind, the short time they are to stand in the field. In the year 1775, ten thousand stone were put into tramp-ricks the fourth day after cutting. In a country so wet as many parts of Scotland are, expedition is of mighty consequence in the drying both of hay and corn.

With respect to hay intended for horned cattle, it is by the generality held an improvement, that it be heated a little in the stack. But I violently suspect this doctrine to have been invented for excusing indolent management. An ox, it is true, will eat such hay; but I have always found that he prefers sweet hay; and it cannot well be doubted, but that such hay is the most salutary and the most nourishing.

The making hay consisting chiefly of red clover, requires more care. The season for cutting is the last week of June, when it is in full bloom: earlier it may be cut, but never later. To cut it later, would indeed produce a weightier crop; but a late first cutting makes the second also late, perhaps too late for drying. At the same time, the want of weight in an early first cutting, is amply compensated by the weight of the second.

The additional labour required to make hay of red clover, arises from the largeness of the stem, and the hazard of the leaves dropping off in moist weather. I have tried two methods,

One

One is, to let it lie in the swath two days, and longer if the weather be unfavourable. The swaths must be turned over and over two or three times every day, but not unless the weather be dry. It will then be ready to be put into cocks, containing each about two stone. After two, three, or four days, according to the weather, let two cocks be put into one; and so on at proper intervals till ready for the tramp-rick. The other way, more expeditious, may be ventured on where ryegrass is mixed with the clover. Stir it not the day it is cut. Turn it in the swath the forenoon of the next day; and in the afternoon put it up in small cocks. The third day put two cocks into one, enlarging every day the cocks till they be ready for the tramp-rick. Sixteen pounds of red clover cut in the bloom, are reduced to four pounds when sufficiently dry for keeping. I have tried, but without success, to prepare it for keeping with a less diminution of weight. Ryegrass cut in the bloom loses of weight the same proportion; which was contrary to my expectation.

When the season is too variable for making hay of the second growth, mix straw with that growth, which will be a substantial food for cattle during winter. This is commonly done by laying strata of the straw and clover alternately in the stack. But this method I cannot approve: if the strata of clover do not heat, they turn mouldy

mouldy at least, and unpalatable. The better way is to mix them carefully with the hand before they are put into the stack. The dry straw imbibes moisture from the clover, and prevents heating.

I must add in general with respect to hay of whatever kind, that if the weather be so wet as to prevent cocking in the ordinary time, there ought to be no intermission in turning the swaths; which will help to evaporate the moisture, if there be any motion in the air; and at the same time, prevent the swaths from sinking into the ground among the uncut grass, which never fails to blanch it.

The expence of making an acre of hay, composed of ryegrass and yellow clover, is, in a tolerable season, from four to six shillings; and from six to eight if composed of red clover. This however is an uncertain computation, the expence differing greatly in a good or bad season.

I will not stop to give any rule for making hay of natural grass, termed *meadow-hay*; because in a well-conducted farm there ought to be no meadow-hay. This is made evident in the chapter *Rotation of Crops*.

In the yard, a stack of hay ought to be an oblong square, if the quantity be greater than to be easily stowed in a round stack; because a smaller surface is exposed to the air, than in a number of round stacks. For the same reason, a stack of

pease ought to have the same form, the straw being more valuable than that of oats, wheat, or barley. The moment a stack is finished, it ought to be covered; because the surface-hay is much damaged by withering in dry weather, and by moistening in wet weather. Let it have a pavilion-roof; for more of it can be covered with straw in that shape, than when built perpendicular at the ends. Let it be roped as directed above for corn-stacks; with this difference only, that in an oblong square the ropes must be thrown over the top, and tied to the belt-rope below. This belt-rope ought to be fixed with pins to the stack: the reason is, that the ropes thrown over the stack will bag by the sinking of the stack, and may be drawn tight by lowering the belt-rope, and fixing it in its new position with the same pins.

The stems of hops, being long and tough, make excellent ropes; and it will be a saving article, to propagate a few hop plants for that very end.

A stack of ryegrass-hay, a year old and of a moderate size, will weigh, each cubic yard, eleven Dutch stone. A stack of clover-hay in the same circumstances weighs somewhat less.

I conclude this article with observing, that till lately the making hay was little understood in Scotland; nor to this day is it generally understood. The method was, to expose it as much as possible

possible to the sun and wind, and never to give it rest till it was so dry as to be grindable in a mill; and rendered a *caput mortuum*. The poor animals reduced to such food, were truly to be pitied: is it wonderful that they were too feeble for work? But this made no impression, as the feebleness of the cattle was but in proportion to the laziness of the men. They had no check of conscience for being idle, because they were educated in that way, and knew no better.

CHAP. IX. FEEDING FARM-CATTLE.

HAVING discussed the management of corn and hay, what naturally follows is, to apply them to the maintenance of farm-cattle: for to consider corn as the food of human beings, falls not properly under any branch of agriculture.

As in this chapter are contained many different matters upon which the profit of a farm greatly depends, I wish what I have to say may be clearly apprehended. In that view the chapter is divided into five sections. Green food is the subject of the first; dry food, of the second; feeding for the butcher, of the third: the fourth contains rules for the wintering of cattle that are not

not intended for immediate sale; and the fifth, rules for buying and selling cattle and corn.

I. GREEN FOOD.

I begin this section with the summer-food of farm-horses. The manner of feeding them during summer, is and has been various through Scotland: none of them good. Some time ago, horses were fed in balks between ridges of corn; which required the attendance of men, and wasted much time. In many parts, horses are reduced to thistles; the time of the men being consumed in pulling, and of the horses in eating. In some places, a part of the common pasture is reserved for them, termed *hained grafs*. The man appointed to attend them falls asleep, and suffers the horses to trespass on the corn. Dogs are employed to chase them from it: they run about; and their fatigue is little less than when at work. To prevent this, the horses are sometimes tethered on the hained grafs: the half is lost, being trodden under foot; beside that they often break loose, and destroy the standing corn. The least exceptionable is a grafs-inclosure; and yet far from deserving approbation. In the first place, where the grafs is so rank as to afford plenty of food to the horses in the intervals of work, a fourth part at least is trodden under foot: the horses beside are pestered in hot weather

ther with flies, and cannot feed with ease. In the next place, they have no time for resting; and much time is lost in laying hold of them for the yoke. Lastly, few inclosures in the hands of a tenant, are in so good order as to keep in horses when they see corn; and if they once break out, it is in vain to think of imprisoning them after. The approved method to prevent every inconvenience, is to feed the horses with cut grass, under cover. In the interval between the work of the forenoon and afternoon, they can fill the belly in an hour, and have time to rest another hour: nor is a moment lost in yoking.

Several plants serve this purpose, sainfoin, lucern, red clover, white clover, ryegrass. Red clover is the best. Sainfoin and lucern early cut are excellent food; but when they turn strong and reedy, horses are not fond of them. The disadvantage of white clover and ryegrass, is, that, being small plants, they are not easily collected in heaps for food. Red clover is extremely luxuriant: it is easily collected: and it ought to be easily collected; for to feed properly a horse of a middle size, requires ten stone a-day. It flowers the first week of June; but in rich soil it will rise to eighteen inches before flowering. So rapid is its growth, that in good soil it may be cut thrice in a year, and afford over and above some pasture. It should be cut in the morning when moist with dew:

dew : it is less palatable when cut dry. The cutting ought to begin long before flowering ; that all may be cut before it is too old, and that it may grow the faster for a second cutting. These considerations are not sufficiently attended to : people are loath to cut till the clover is fully grown ; tho' early cutting will upon the whole afford more food, as well as more palatable food, to horses especially, which dislike old clover. I despair not to see all the corn-farmers in Scotland, depending on red clover for the summer-food of their cattle ; and then we shall no longer be stunned with loud complaints commonly thrown out as excuses for idleness : " How can I improve, having no food
" for my horses but bare lea or thistles ? they
" cannot work on such food ; I cannot stir a
" foot." A horse works as he is fed : it is surprising what work he will perform upon cut clover, without losing flesh. Many a summer, for seven or eight weeks running, have my horses been daily employed in bringing lime from a quarry fifteen English miles distant, fed on red clover only ; and at the end of the season, as plump and hearty as at the beginning. Let another article be considered. In every farm, a great proportion is left out for pasture, if that can be called pasture which affords little or no food. A single acre of good red clover, will give more food than fifteen or twenty such acres. How much

much better might these acres be employed in bearing profitable crops of corn?

But a skilful farmer will not confine himself to red clover for summer-food. There are other grasses that spring more early, and grow later than red clover. Ryegrass, ribwort, and yellow clover, flower a month before red clover, are fully ready for cutting green the middle of May, and if cut at that time continue growing, and may be cut a fortnight after red clover is gone. To enlarge the period of green food for cattle, is a desirable object in husbandry. It affords plenty of food both early and late; it saves pasture-fields in spring till the grass cover the ground, which retains the dew, and shelters the grass-roots from withering winds; and it enables the farmer to leave his fields rough at the end of the season to keep out the frost during winter, instead of eating them bare, which is the ordinary practice. Now these salutary effects, all of them, may be procured by a very simple operation; which is, to sow part of the field with ryegrass, ribwort, and yellow clover mixed. These plants are ready for being cut the middle of May; and if the season prove favourable, they may be cut again as late as even the middle of November. Cut grass is of all the cheapest food, and the most agreeable to horses. Therefore to add a month of this food, is a valuable improvement, especially during spring: for however nourishing dry food may be,

be, yet a horse put upon green food turns remarkably more agile and plump. I proceed to the summer-food of horned cattle. A beast that chews the cud, takes in at once a large

* It may be agreeable to bring under one view the grasses mentioned above, with respect to the season of their shooting and ripening.

Ryegrass sown in spring with corn, shoots the year following, from the 20th to the 30th of April, according to the soil and season. It flowers from the 1st to the 10th of June. The flower continues about eight days, falls off, and the seed at that time begins to form. The seed is ripe between 1st and 10th July. When it is fully formed, the stalk begins to turn brown; and more and more so till the seed falls, which is about the end of July.

Ribwort shoots the last week of April. The head in a thriving plant is three inches long, full of seed, which is completely ripe about the 10th of July. Upon the head are found at the same time seed formed, flowers, and part that has not yet flowered.

Red clover shoots from the 1st to the 10th of June; and in eight days after begins to flower. It continues in flower twenty days; and about the end of July the seed is ripe. The progress of white clover is precisely the same.

Yellow clover shoots the last week of April, and flowers till August. On a stalk is found at the same time, seed ripe, seed half ripe, flowers, and shoots just beginning. It accordingly resembles pease, and grows a long time. Its continual growing keeps the stem full of sap. The time of cutting plants for hay is in the middle of their flowering; but as yellow clover flowers much longer than the others mentioned, it affords a greater latitude for cutting without injuring the hay.

large quantity of green food, especially of red clover, which is extremely palatable when young. So large a quantity is apt to ferment with the heat of the stomach, so as sometimes to make the creature burst. This is considered as a formidable objection to the feeding horned cattle on red clover. But it is easily obviated, by feeding them in the house: servants will not readily give more than sufficient, when cutting and carrying is a work of labour. And red clover should always be cut for food; for where cattle have liberty to pasture, more is trampled down than is eaten. At any rate, bursting may be prevented even when cattle are allowed to pasture. Indulge them but half an hour or so, for two or three days when the clover is dry; after which there is no hazard. If yellow clover and ribwort be sown with red clover, there is little or no hazard of fermenting to such a degree as to be hurtful. White clover is no remedy: it ferments in the stomach as much as red clover.

Red clover cut green, is preferable to all other food for milk-cows. Being soon filled, they have much time to rest, which increases the quantity of milk. The milk at the same time is richer and higher coloured, than from any other food.

Red clover is good food for sheep; but the cutting it for them would be too expensive. White clover at the same time is their favourite, which is never wanting in good soil, growing naturally.

One signal advantage of feeding horses and horned cattle in the house during summer, is their being protected from heat and insects. And it is a still more signal advantage, that the dung turns to much better account, than when scattered during summer in a pasture-field. Horse-dung in a pasture-field is totally lost: it dries, and withers away, not to mention that its heat burns the grass it falls on. Dung is an article of great importance, especially in a farm distant from other manure. And a dunghill, procured by feeding on cut grass, may be considerably increased by adding to the heap every weed that grows in the farm; which at any rate ought to be cut, to prevent feeding.

The carrying cut grass from the field to the stable is a laborious work; and the only circumstance that weighs against cut grass in competition with pasture. A horse of a middle size will eat ten Dutch stone daily; some go the length of seventeen: an ox or a cow will eat eight stone. Supposing in a farm ten horses, ten oxen, and six cows: they will consume 228 stone a-day. If the clover be at any distance, that quantity requires a cart going continually from morning till evening. Computing a cart at three shillings *per* day, the expence for the six summer-months is no less than L. 25, 4s. Even this high expence, is far from counterbalancing the advantage of feeding cattle in the house. The expence, however, is so considerable,

derable, as to make it of importance to lessen it. In that view, I recommend the following plan, the purpose of which is, to carry the cattle to their food, instead of carrying food to the cattle. Erect a moveable shed in the field, all of wood, the back considerably higher than the front, in order to have a slopping roof against rain. Sixteen feet in wideness is sufficient for a beast of any size; the length corresponding to the number of cattle that are to be fed. On the back at the heads of the cattle, a deal is hung with hinges, to be lifted up for throwing food to them. Upon the ground along the length of the house, three beams are laid, crossed with spars an inch distant from each other. The channel or gutter behind the cattle, is lined with a deal in the bottom, and one on each side, to convey the urine from the cattle to a pit filled with rich earth; which I hold to be preferable even to dung itself. The three beams covered with spars make a vacuity below, which receives the urine at the first instance, and preserves the cattle dry. This is an important article in feeding cattle, which every animal at liberty is fond to procure to itself. There is no necessity for racks in this shade; on the contrary, horses eat more conveniently in the natural way, by bending down the neck to food. The only thing necessary is a board between their fore feet and the clover, to save it from being trampled under foot. It is proper that in a corner a bed
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be erected for a servant, to attend the cattle during night. The deals of this shade must be held together with wooden nails, so as easily to be taken down, and set up again where it may be wanted. It should be placed at the lowest part of the field; because the clover is more weighty, than the dung it produces. It is possible to set a little shed on wheels, to be carried from place to place, without being taken down; but that will never answer for a shed of thirty or forty yards long. Such a shed is proper in every farm, where red clover is annually raised in the course of cropping; and the expence will be the less grudged, considering that it also answers for consuming turnip and cabbage in winter. Let the expence be computed of carrying these to an immoveable shed; and in a farm of any extent, it will be found that the expence thus saved, even in a single year, will equal the cost of the proposed shed. In a small farm, where red clover enters not into the rotation of crops, and yet is necessary for summer-feeding; the most convenient way is, to inclose six or seven acres as near as may be to the farm-offices, upon a part of which there should always be a crop of red clover in rotation. In that case the carriage is a trifle. I have only to add, that room should not be spared; for horses are hurt as much as horned cattle by being crowded,

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The proper seasons for disposing of cattle fatted on grass, are the June markets, and those of December and January. With a view to the first, early grass ought to be provided, and late grass with a view to the others. In an open winter, there is no difficulty to preserve grass-cattle fat through December and January: in a hard winter, the addition of a little hay will do.

Next in order is the feeding cattle in a pasture-field. White clover is for pasture the best grass known in Britain, being extremely palatable to cattle of every kind. It is a native of Britain; and like a strawberry it throws out flagellæ or runners from the stem, which take root and become new plants. But as this is a work of time, it is more profitable to stock the field with it at once. Good seed is weighty, and full without dimples: it is red when hurt in drying. A field intended for pasture, requires a mixture of grasses: every species of animals has its favourite grass; and when animals of different species feed together, not a single stump is left. Different grasses also, having different times of flowering, keep the chain of food more complete during the season. Ryegrass for example answers spring-food better than any other plant, and continues longer after autumn. But white clover during summer holds out better than ryegrass. Different grasses at the same time ex-
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cite the appetite : an ox will leave turnip for cabbage ; and after feeding plentifully on both, will take kindly to hay or straw. The proper quantity of seed to an acre intended for immediate pasture, is ten pounds white clover, five pounds yellow clover, as much ribbed grass, and two wheat-firlots of ryegrass.

An inclosure proper for pasture, ought to have the following properties. It ought to be well aired. Second, well watered. Third, well sheltered. Fourth, the larger the better. And, lastly, the grass ought to be so rank as to afford a full bite. With respect to the first, a field well aired makes cattle feed kindly : in a hot day, they go to the highest part for fresh air : if they have neither fresh air nor water to resort to, they fret, and lose flesh. The want however may be supplied artificially, by clumps of evergreens scattered through the field, to shelter them from the sun. With respect to the second, plenty of water for drinking is not alone sufficient : there ought to be plenty for bathing, in a hot day : cattle are never more at ease in such a day, than when they are plunged in water. With respect to the third, it is not sufficient that cattle be sheltered against heat : shelter against cold is still more necessary. By proper management, the chain of grass may be carried on in tolerable weather till the end of the year ; but unless the cattle be protected from cold blasts, grass will do them little good. The clumps

clumps mentioned planted in the form of a cross, will afford shelter from whatever quarter the storm comes. With regard to the fourth, the field ought to be so large as to give cattle their natural range. Every species of animals that feed on grass, have a natural range in feeding; and to confine them within narrower bounds, is to them a sort of imprisonment. Sheep have a wide range; and ought to have, because they delight in short grass: give them eighty or ninety acres, and any fence will keep them in: confine them to a field of seven or eight acres, and it must be a very strong fence that keeps them in. A range of fifty or sixty acres is sufficient for horses; and a still narrower range for horned cattle. In opposition to the field described, advert to cattle cooped up in a small inclosure of eight or nine acres, surrounded with high hedges. In summer they are stifled for want of air, are pestered with insects, and lose fat instead of gaining. To examine the progress of fattening, I weighed twenty stots the first day of May and the first day of the five succeeding months. Their quickest advance was in May and September, being at an average two pounds daily each. I could not attribute this to any other cause, but to less heat and fewer insects than in the three intermediate months. With respect to the property last in order, the benefit of a full bite is too obvious to need explanation.

A pasture-field bare of grafs in spring, having no protection against withering winds, turns hard and unfit for vegetation, especially after wet weather. But where a field springs early, and is covered with grafs before drought sets in, it continues moist and tender, by retaining dew and keeping out drought. To encourage early grafs in spring, the field ought to be left rough in winter; which keeps the ground warm, and protects the roots from frost.

Ragwort is a troublesome guest, as it never fails to infest rich pasture-fields: it is not only a robber, but overshadows the grafs, and renders it unwholesome. I am at a loss however whether to call it a weed or an useful plant. As it bears no seed till the third year of its growth, it cannot propagate in land under tillage: in pasture-land, it dies indeed after dropping its seed, but new plants spring from that seed, and have a succession without end. Many things in appearance noxious, have been found useful; of which this plant is an instance. The same means will prevent its noxious effects, and make it profitable. Ragwort in flower was never seen in a field pastured with sheep. Why? because that animal is excessively fond of it. Therefore, in every pasture-field, for some years after it is laid down, there ought to be a proportion of sheep. They prefer ragwort before any other vegetable; and experience pronounces, that every food is wholesome which an animal

animal is fond of. Lincolnshire sheep do best ; because a fence sufficient for horned cattle, is more than sufficient for them. Sheep are singular with respect also to other food. They are fond of the tender shoots of broom and whins ; and no less so of the fruit of the horse-chestnut.

The rush may be compared to ragwort ; it is a troublesome weed ; and yet may be made in some degree profitable. Whether it should be classed among the evergreens, appears doubtful from the following account of it. It springs six or seven inches high in April, grows on till August, when the seed appears at the side of the stem, five or six inches below the top. While the seed is drawing toward maturity, the part above withers gradually ; and when the seed ripens and falls, the part below withers down till within a foot or so of the ground. That part continues green all winter, but dies away before next summer. In place of the stems that thus die, fresh stems arise, which, as observed above, make a figure in April. Whether these stems arise from seed, or from the bulky root, or from both, I cannot at present determine.

As the rush is an aquatic, and grows so vigorously as to destroy all other plants, it ought to be rooted out if possible ; not only because it is a bad pasture-grass, but because the infallible way of rooting it out is, to lay the ground dry ; which makes a double improvement. But if this cannot

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be got done at a moderate expence, the resource is, to make all the profit of it that is possible. Rushes cut in June while young and tender, and dried into hay, make tolerable winter-food: a fresh growth ensues which is proof against frost, and is not unfavoury to cattle that run out all winter.

In the month of April, while grass is still so short as not to afford a bite to horned cattle, I have seen fourteen cows living on rushes. At that season, they are to horned cattle almost as palatable as red clover. They are rejected when old; and so is even red clover.

A sprat is not an evergreen, for it dies away in winter. It is an aquatic, like a rush, but thrives with a less degree of moisture. It may be of some use for hay when cut in June; and the after-growth is not unpalatable when eat young. But after seeding no beast will touch it.

2. D R Y F O O D.

I proceed to dry food. As hay is of use to cattle of every kind, it is a capital object in husbandry; and not the less capital, that, in my thought, it may be carried to greater perfection than is commonly done. To give satisfaction, we must enter into an examination of the different grasses that are used for making hay. Red clover is a succulent plant of the leguminous tribe, that
flowers

flowers about the beginning of June, and rises to the height of between three and four feet. Ryegrass is a culmiferous plant, dry and solid like other plants of that tribe; rising commonly in good soil to three feet and above. It shoots the end of April or beginning of May; and above all other plants hastens to perfect its seed. Yellow clover and ribwort, both of them leguminous plants, are more tender and succulent than ryegrass; but less so than red clover: they rise commonly to three feet. They shoot at the same time with ryegrass, but perfect their seed not altogether so soon. Ryegrass, because of its solidity, is of all the best food for horses; and next to it, yellow clover and ribwort. Horned cattle delight in leguminous plants, red clover especially: it is probable that tender grasses are fittest for animals that chew the cud. White clover blooms and perfects its seed at the same time with red clover: it makes excellent dry food for sheep; but as it seldom rises above eighteen inches, it is less proper for hay than any of the others mentioned; and upon that account, is often left out in the mixture of grasses for hay.

With respect to the time of endurance, red clover cannot be depended on for hay longer than two years: the third year, it makes at best a scanty crop, and frequently vanishes altogether. Ryegrass, ribwort, and yellow clover, stand good three years. From that time, the product lessens gradually;

gradually; and after the seventh or eighth year they afford little pasture.

The general practice of Britain for hay, has been to mix ryegrass and red clover with a small proportion of white clover; which I believe continues to be the practice in many places. I cannot help condemning it, as the child of ignorance or inattention. Two weighty objections occur. The first is, that when the red clover is fit to be cut for hay, which is about the beginning of July, the ryegrass-seed is ripe. And what follows? The ryegrass that year grows no more than barley or wheat cut when the seed is ripe; whereas if ryegrass be cut before the seed is formed, it grows all summer, and even all winter, till it makes way for new shoots in spring. It may possibly be thought, that the seed, like that of other culmiferous plants, is more than sufficient to make up the scantiness of subsequent cuttings; but in drying for hay, most of it is lost, some in the field, some in the stack, and some in the hay-loft; little being left but the dry straw, which cattle do not willingly eat. The other objection is of still greater weight. After a crop or two of hay, the field is surrendered to pasture. The red clover wears out the second year, leaving nothing but the ryegrass, which continues but another year in perfection: and the small proportion of white clover has not yet had time to spread over the field. Thus, after the second year, the pasture

sture is but indifferent; and turns worse and worse till the field have time to stock itself with natural grasses. Nor is that all: while the field is but half-stocked with sown grasses, weeds take possession of the vacuities, and accelerate the dwarfing of the ryegrass and white clover. And if the red clover happen to be a scanty crop the second year, it encourages weeds no less than a scanty crop of pease.

I venture to suggest a better plan for hay than any I have read of. I pronounce the best hay for horses to be a mixture of ryegrass and yellow clover, which flower together and are fit to be cut for hay the beginning of June, when still in flower and the seed not formed: at that time, being full of sap, they are in perfection for hay. When cut so early, they grow again vigorously, and afford a second crop end of September; or excellent pasture, if the season be unfavourable for hay. When the first cutting is later than beginning of June, the stem turns dry and woody; and much of it is rejected, if a horse be not extremely hungry. But I recommend this to gentlemen only and farmers, for feeding their own horses. In the view to sell hay, their profit I acknowledge will be greater in cutting when the seed is ripe, because the seed is a profitable article. The hay, it is true, separate from the seed, is no better than straw: but that is no objection to an innkeeper; for the less a travelling horse

horse consumes, the profit is the greater. My reason for chusing these two plants for hay to horses is, that, of all leguminous plants, yellow clover approaches the nearest in solidity to ryegrass, and that they dry well together. Ribwort is left out, as being less fit for horses; and with plenty of feed the two plants chosen will make as weighty a crop as the ground can bear. Three wheat-firlots of ryegrass, and ten pounds of yellow clover, make a sufficient doze for an acre. And when cut early, as it ought to be, the crop must be very weighty if the cutting cost more than eighteen pence *per* acre.

For hay to horned cattle, the mixture ought to be red clover, yellow clover, and ribwort. Red clover, it is true, falls properly to be cut a little later than the other two; but as it is choice food for horned cattle, it is better to cut it along with the other plants, than to lose their foggage by cutting them too late. Ten pounds red clover, six pounds ribwort, and four pounds yellow clover, are sufficient for an acre.

A farm-horse, during winter, requires at least two lippies of oats daily: in spring, which affords more working-hours, they are encreased to three. The rest of his food is hay or straw: bean-straw is the best, pease-straw next, and after it good oat-straw. Upon that food, a pair of good horses will labour ten hours a-day, and plow an acre of cultivated land; or draw on a smooth road

a hundred stone in a cart, sixteen English miles. Such work they can perform daily without losing flesh.

When too much hay or corn is given to a horse at once, he eats greedily, and is apt to surfeit on it. On this account, as well as to save food, better to give it in small parcels at intervals, in which case every particle will be eat up clean. Were it not for the expence, the best way of feeding a horse with hay would be to give it out of the hand. As for corn, a horse when hungry, is apt to swallow it without chewing; in which case it passes entire and gives little nourishment. Therefore with oats mix chaff or cut straw, which require chewing. If that labour be grudged, there is an instrument contrived for bruising oats, which has a promising appearance. I will not, however, venture to recommend it, because I have no experience of it.

A dairy may be turned to great account. A good cow, during the six summer-months, will give at a medium twelve Scotch pints of milk daily; the butter of which, with the skimmed milk, may amount to eighteen pence *per* day, and thirteen pounds ten shillings in the six months. The grazing of such a cow for that time, will not cost above forty shillings, which makes eleven pounds ten shillings of profit.

3. FEEDING FOR THE BUTCHER.

HORNED cattle continue to grow till they are full six years old ; during which time they do not readily take on fat, nor carry much tallow. The proper time to enter them upon fattening food, is at the age of seven. There is an additional reason, that three years work can be got from them, which in all events will do more than balance the expence of their food.

As the demand for butcher-meat in Scotland increases rapidly, the feeding cattle for the shambles has become an interesting article to the farmer. Thirty years ago, he had no temptation to keep fat on his cattle during winter, because salt meat was our only food during winter and spring. We have now fresh meat in plenty, all the year round ; only a little dearer in spring ; and of that circumstance a provident farmer will avail himself. The difference of a month, will sometimes add a halfpenny to the price of a pound of beef ; which, upon an ox of sixty stone, makes forty shillings for that month's feeding.

A field sown with the grasses above mentioned, may be depended on for fattening from the middle of April, in a warm soil, till the middle of November : nor will they fall off till the middle of December, if frost and snow keep away. Hay, though greatly preferable to straw
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of any kind, yet will not fatten horned cattle for the market without green food. It indeed keeps the fat upon them; but adds little or none. It is however profitable to feed a fat ox with hay during winter; because the additional price got in the spring, will defray the expence of the hay. Some years ago, I fed twelve oxen with hay through winter; and though they were not a pound heavier in April, I sold them at that time for double the sum I paid for them. An ox of a middling size, eats thirty pounds of hay, Dutch weight, in twenty-four hours, and drinks forty-eight Scotch pints of water. An ox of a large size will eat forty pounds, and will drink in proportion.

Of all the beasts I know, a spayed quey is the most profitable both for labour and for the butcher. She is little inferior to an ox in strength; but much more agile, and consequently better fitted for travel. She will work even till eight years old, and still be fit for feeding fat. People of delicate taste prefer her beef.

It is a great loss to have a cow to maintain that has missed calf. The only profit is to feed her for the butcher. She feeds the faster after having received the bull. But care must be taken not to admit the bull, but so as that she may be sold fat three months before the time of calving; for during these three months she commonly loses fat.

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Considerable profit may be made by feeding small cattle bred in the Highlands, purchased when four years old at a small price, because they are unfit for work. This branch of commerce is accordingly well understood.

A sow is a profitable animal : it feeds greedily on cut clover ; which, with the offals of the kitchen, dairy, and barn, prepare it finely for being fatted in a short time with more nourishing food.

The feeding of calves for veal is also profitable. The calf even of a middle-sized cow, after sucking her for six weeks, will sell at thirty shillings. The same cow will in six months feed four calves for the butcher, sometimes more ; and after all, will give milk two months longer. For making fine veal, the calf ought to be blooded frequently, kept from light, laid clean and dry, and get chalk to lick.

For some years past, a shed erected upon pillars, with intervals of eight or ten feet, has been used for stall-feeding. Such a shed I pronounce to be too cold for our climate. A house so constructed as to avoid the extremities of heat and cold, answers much better. Upon a feed of turnip in hard frost, cattle may be observed to contract their feet together, and to tremble as in an ague. No animal can feed well in distress. On the other hand, cattle in a close house, and in a hot day, may be observed panting for want of breath. Therefore let the feeding-house have
many

many windows or air-holes, to be shut or opened as occasion requires.

As to the time of housing cattle for feeding, it is evident, that as grass is more easily raised than cabbage or turnip, the longer stall-feeding is delayed without losing fat, the better for the farmer.

With respect to the food proper for stall-feeding, turnip, cabbage, colewort, potatoes, carrot, are all proper, and may be raised in every farm. For feeding in perfection, all of them ought to be provided; for which there is more than one reason. In the first place, variety excites the appetite: next, some of these vegetables endure the winter better than others: turnip, for example, does not answer for spring-food, so well as cabbage and colewort. Therefore, as far as is consistent with variety, I would be sparing of the vegetables that are the least hurt by winter. Potatoes answer best for the concluding food. If sufficient store be provided and well preserved, which is an easy matter, all complaints of wanting green food in spring must be at an end. Every animal is fond of potatoes, not even excepting a horse. They are a choice food for milk-cows, and produce plenty of milk; which has no rank taste more than where fed on hay or grass. And yet after all, how many indolent farmers still remain, who for want of spring-food are forced to turn their cattle out to grass, before it is ready for pasture;

pasture ; which not only starves the cattle, but lays the grafs-roots open to be parched by sun and wind. One precaution, however, is necessary with respect to grafs in proper condition for pasture : surrender it not to the cattle at once, which would give a looseness, but for a few days let them feed an hour or two only.

Preparatory to the feeding cattle in the house with cabbage and turnip, they ought to be made acquainted with that food in the field, by getting now and then small feeds of it ; beginning with cabbage, which they soon take to as being soft, and then proceeding to turnip. Without being thus prepared, some beasts have been known to fast obstinately for days, before they would touch them. In the house, it is common to fill the stalls at once for saving trouble. This is wrong : cattle are so fond of cabbage and turnip after acquaintance, as to be apt to surfeit upon them. A hungry horse, by eating too much corn at a time, takes a loathing of that food ; and his loathing continues for days. Begin with giving a bullock one turnip after another, and he will not readily surfeit. One bullock of ninety stone Dutch thus fed, ate up thirteen Dutch stone before he stopped ; and in twenty-four hours he devoured thirty stone. This was the third part of his own weight ; and every bullock in health will do the same, when thus fed. Therefore, after cleaning the turnip, let the feeder begin in the morning with

with throwing a turnip or two to every bullock : let him repeat the dose till they turn shy : let him then give them cabbage in the same manner ; and conclude with handfuls of hay. When they are thus satisfied, prepare them a soft bed as an invitation to lie down. Leave them to chew the cud and sleep, till they rise of their own accord. Repeat the dose as before. As they grow fat, they will reject the coarser parts of the food ; which may be given to winterers, or to swine. If the turnip be large, there is no danger of giving them whole. But they are apt to choke upon small turnip ; which therefore must be cut into small bits that can be easily swallowed. A machine to bruise turnip for eating would be an useful invention.

These instructions are intended to make cattle eat the greatest quantity possible ; it being certain, that the more a bullock eats with an appetite, the sooner he grows fat. It is bad œconomy to spare food in this case : a certain quantity daily is requisite to preserve a beast from falling away ; and an addition is necessary to put fat on him. Therefore the sooner he is fatted, the greater proportion of what is necessary for bare maintenance, is saved.

To keep cattle clean and well littered, is to them half food ; and this may be easily done in a shed constructed as described above. Let them be combed every day, washed with water every week,

week, and bled every month; for these all contribute to fattening.

Most of the cattle in this country sold to the butcher, are fed upon grass, and sold in November at two pence *per* pound, or two pence half-penny. But as the profit here is very small, a farmer who is studious of his interest, will have a provision of cabbage and turnip for winter, in order to sell his cattle at double price in spring.

It has become a pretty general practice, to feed cattle in the field with turnip, cabbage, and other annual greens. There is not another way of fattening cattle so cheap; nor another way by which so much dung can be raised in a farm. These are important objects. But what I chiefly insist on is, that there is not within the invention of man, a more effectual method for improving a gravelly or sandy soil. Nothing indeed is more hurtful to clay or rank loam than poaching; but the poaching a light soil takes away the pores, makes the earth more compact, and more retentive of moisture. A crop of turnip or cabbage on stiff land, ought not to be fed in the field; but in a shed, such as above described, or in an adjacent dry field.

To be successful in this article, let cattle be chosen that have been accustomed to run out in winter. Cattle that have been always housed in winter, are too tender for field-feeding: they will never turn fat.

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There requires more management in feeding cattle with cabbage and turnip in the field, than is commonly practised. What must one think of the slovenly method of turning cattle into a turnip-field, to feed at random? I hope this is rare; but another method is not rare, which is, to inclose with flakes a portion of the field, and within that small space to confine the cattle. Is it not obvious, that by dunging, pissing, trampling, a great part of the turnip must be lost, or become nauseous? To prevent that loss in a light porous soil that turns more solid by poaching, I have always practised the following method. Supposing the inclosure to be an oblong square, which is the most convenient for flakes, begin at one of the short sides, and from the fence throw the turnip towards the middle of the field, clearing as much ground as can be done at one throw, which may be thirteen or fourteen feet. Separate this vacant space from the turnip by flakes. Let the flakes incline inward to the field, which will prevent the cattle from rubbing them down. Introduce the cattle into this void space, and begin with throwing over to them, from time to time, the turnip that were taken up, so sparingly that they may eat without trampling them under foot. After these are clean ate up, clear another strip of the same breadth with the former, by throwing over to the cattle the turnip that grow there. Remove the flakes to the side of the growing turnip,

turnip, and go on till the field be ate up. In this manner, the whole field will be knead and poached, so as totally to alter the texture of the soil. But because to give the cattle no other bed, would greatly retard the progress of fattening; an adjacent grass-field is necessary, in which they should be put every night for a dry bed. In this grass-field place hecks, for feeding the cattle with hay or straw; as nothing contributes more to expeditious fattening, than alternate green and dry food.

Frost is the only enemy to this manner of feeding. In frost, the digging up the turnip is expensive; and they give the cattle a looseness, which makes them lean instead of fat. Hard frost destroys the turnip altogether. I have tried several preventives. At the corner of a field, I built in a stack all the turnip that grew on four acres. They remained entire six weeks; but after that time, they began to sprout, especially about the centre, which exhausted the turnip, and rendered them less palatable. I tried another method; which was, to fill a large house with turnip, on the first appearance of frost. The warmth of the house made them sprout sooner than in the former way. A third experiment was to dig a pit in the field six or seven feet deep, where I stowed the turnip and covered them with three feet of earth, reckoning that this would prevent vegetation. But they sprouted

ed as soon as in the house. A fourth experiment was to build in the field what would fill two large carts, covering the heap with ferns or straw. In this situation, they were longer of sprouting; but they were more exposed to frost. Upon the whole, the best method, as appears to me, is to store up in a house as many turnip as will serve the cattle a fortnight. As after that time they begin to wither, give them to the cattle though the weather be fresh; and then fill the house again. This is a resource against a fortnight's frost; and as a farther resource, a few heaps may be collected in the field, ready at hand if frost set in. A resource still more commodious of late invention is mentioned below page 208. The best preventive of all against a long frost are potatoes, which may be easily preserved in a house during the longest frost. Cattle are fond of potatoes, and they make a good change of food to supply the want of turnip or cabbage during frost. The same method may be taken with cabbage. Carrots are preserved by taking them up, and burying them in sand. Potatoes being more hurt by frost than any other root, they ought to be stored up in a house, and covered with dry straw pressed down with litter. But here a precaution is necessary. If allowed to lie too long in their winter-quarters, they will sprout, and be useless. Therefore, as soon as the frost is over in spring, they must be exposed

to the sun and air till perfectly dry; and then laid up where there is a free circulation of air.

Cabbage and turnip give a strong taste to butcher-meat, when not intermixed with dry food. But the remedy is easy: give nothing but dry food for a few days before they are delivered to the butcher. The intermixing dry food with turnip and cabbage in feeding milk-cows, ought never to be omitted; because these plants without that intermixture give a nauseous taste to the milk, cream, and butter.

The feeding cattle with turnip and cabbage in the field, is an interesting article. There are few farms but what are fit for raising green food of one kind or other; and by far the greater part are fit for every kind. Light soil is fit for turnip, both light and loamy soil for potatoes, deep soil for carrots, and strong soil for cabbage. For a dozen of years back, the ordinary profit of such feeding from the end of November to the end of March, has been to double the price of the cattle; which affords a very handsome rent for the land. Nor do I reckon this the capital part: the gain is still greater by the improvement of the soil. No other method is so effectual to convert light porous soil into what is firm and heavy, as the poaching of cattle during winter. To compare it with ordinary manure, would not do it justice. It alters and improves the soil like clay-marle; and these two are the only means I

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am acquainted with, to produce a new soil equal to one originally rich. There are few soils indeed but what may be hurt by cropping; but a soil so improved, can never be hurt so much by cropping, as to be reduced to its original poor state. After such a winter-feeding, it would surprise one, to find ground formerly so loose as not to hold together, become now so solid as to be raised by the plough in solid masses. This way of feeding cattle, is at the same time a good dunging to the field, equal at least to an ordinary dunging from a dunghill. The cattle evacuate abundantly, and what drops from them mixes intimately with the soil: not a particle is lost.

The feeding sheep on turnip and cabbage, ought to be delayed as long as possible, for the reason given above with respect to horned cattle. But as sheep are better protected against cold, there is the less necessity of providing a shade for them. To save the turnip, flakes ought to be used; and a dry bed is still more necessary to them than to horned cattle. Their dry food ought to be white-clover hay, or unthreshed fitches; both of which they delight in. White-clover hay, however, without corn or green food, will not fatten sheep for the butcher. In frost and snow, sheep should always be supplied with hay or other dry food; which prepares them for green food the end of March; at which time a few

few weeks of ryegrass will make them ready for the market, at the dearest time of the year.

Where sheep are fed in the house, which is seldom done except for the use of a family, they ought to be separated by rails from each other; otherwise the strongest wedder will oppress the rest. They must be shorn when put up to feed, and be always kept clean. There must be a heck for holding hay, a place for the turnip or cabbage, and a rip of oats be hung up within their reach. A sheep, like an ox, eats of turnip the third of its own weight in twenty-four hours. The best age for feeding wedders is four or five: short of that age they feed not so kindly, nor tallow so well.

Some land is fitted for feeding; some for breeding only. A farmer who possesses rich land, buys lean cattle from the breeder, and fattens them for the butcher.

4. THE WINTERING OF CATTLE NOT INTENDED FOR IMMEDIATE SALE.

THE food proper for such cattle is, first, coarse grass that they refuse to eat during summer, when they have better food. Second, straw or coarse hay; and, last, what is left by milk-cows, by beasts stall-fed, or by working oxen and horses. With respect to the first, the common but very improper method is, to let them go at large in the
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the field ; and in frost and snow to give them food in hecks. By this method, the dung is almost entirely lost ; and unless the field happen to be well sheltered, which seldom is the case, Scotland is a climate too cold for such management. This is verified in our highland cattle, which never arrive at half their size ; not so much from want of food, as from piercing cold in a mountainous country. To remedy both these evils, an open shed should be erected in the field, for shelter to the cattle in a storm ; and this shed should be in the most sheltered spot, fronting the south. To preserve the food given them during frost and snow, a heck should be put in the shed ; and the dung be carefully collected from time to time. It is evident from what is said, that no cattle are fit to be managed in this manner, but what have been accustomed to lie out all winter.

Where there is no coarse grass for winter-feeding, the ordinary method to feed winterers is in a dung-yard with straw, the half of which, trodden down with the foot, turns to no account. The more provident farmers set up a heck in the yard, which saves some of the straw that is lost the other way.

This method, though common, lies open to many objections : first, it is still too cold for winter ; next, much good food is destroyed by it ; and, third, the dung, by trampling of the cattle,
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is kept from rotting. This matter is interesting, and I beg the reader's attention, while I endeavour to verify these propositions. With respect to the first, the shelter of a yard is far from being sufficient to preserve cattle in a kindly heat, during frosty weather. Such an inclosure is subject to whirling winds, which pinch the cattle even in fresh weather. Observe, that when cattle are brought from a warmer climate to mend the breed, every one is sensible, that during winter a warm house, and plenty of food, should be provided for them. A cow when thus treated gives more milk, and a beast intended for the butcher grows sooner fat. To answer these purposes, I believe it will be found, that the nearer the air approaches to the heat of the blood, the cattle thrive the better. That cattle fed in a yard destroy much straw, is obvious to ocular inspection. Even when straw is put into a heck, one beast no sooner draws out a mouthful, than he is pushed away by another, and loses in his hurry part of what he draws from the heck: none of them are suffered to feed peaceably or quietly. The third proposition is the most important of all. Half-rotten dung trodden under foot, and kneaded together by the cattle, excludes the air totally from the inner parts of the heap; and it is a truth indisputable, that there never can be any putrefaction where there is no air: putrefaction cannot go on without moisture, and as little without air.

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Put a spoonful of cream in an exhausted receiver; and after a year it will come out as sweet as when put in. When a dunghill, after heating, turns cool again, turn it over and admit fresh air, it heats a second time: a stake driven into an open gravelly soil, which admits air into every pore, rots sooner than even in a wet clay-soil that excludes air.

From these premises I conclude with firmness, that the best way of feeding winterers is in a house where there is free ventilation; indulging them only an hour or two in the field when let out to water, longer or shorter according to the weather. I know many judicious farmers, who prefer the feeding on a dunghill, with an open shed to retire to in a storm; and they even hold, that the treading of cattle on a dunghill contributes to its putrefaction. I flatter myself that I have discovered their reason for this opinion. Their practice is, to throw quantities of dry straw from time to time on the dunghill, part of which is eaten by the cattle, and the rest trodden under foot. Straw is elastic, and when laid on a dunghill dry, it admits too much air; in which case the dunghill gains by being trodden on. But where all the straw is used, either in food or in litter, and none of it carried to the dunghill till it be half putrefied; it becomes too compact by being trodden upon; and the air is excluded altogether, which obstructs putrefaction
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no less than too much air. A provident farmer will never waste his straw, by throwing it on a dunghill: he will provide as many winterers, as to consume all the straw that is to spare from his working cattle. I add, that supposing winterers to be as comfortably put up in a farm-yard as in a house, the latter however ought to be preferred; first, because it saves straw, and the beasts are more regularly fed; next, that it is a better way of having a dunghill well putrefied; and, lastly, that the urine of the cattle can be wholly preserved; whereas in a farm-yard all is lost but what happens to fall on the dunghill.

Join another particular not of slight moment. A dunghill separate from cattle, may contribute greatly to the feeding with turnip. A quantity of turnip taken up in the beginning of a frost and laid upon the dunghill, will be preserved entire for weeks, perhaps as long as frost commonly lasts in this variable climate.

5. RULES FOR BUYING AND SELLING CATTLE AND CORN.

THE common and constant way is, to sell cattle by the eye; which is far from being equal between the farmer and the butcher. The former has but a very uncertain guess of the weight; the latter, who is dealing the year round, can guess very near. Fair commerce is in general the

the most beneficial; and every thing that approaches to chance or gaming is hurtful. To bring on a perfect equality between the seller and buyer, I propose, that every beast should be sold by weight, and that the weight should be ascertained by a balance. The most convenient one I know is a steel-yard, being the fittest for weighing heavy goods; and a steel-yard I have used with ease and success many years.

But it is not sufficient to have the weight of a living beast ascertained. Different parts are very different in their value; and there is a rule for ascertaining the proportion of these different parts, by which their weight may be known, almost with equal certainty as the weight of the whole beast. My experience goes no farther than to Scotch cattle sold fat, to which the following proportions will nearly answer. The four quarters make the half of the weight of the bullock. The skin is the eighteenth part. The tallow the twelfth part. These make twenty-three thirty-sixths of the whole; and the head, feet, tripe, blood, &c. make the remainder, being a third part and a little more. These offals never sell by weight, but at a certain proportion of the weight of the beast. They commonly draw ten shillings and sixpence when the bullock weighs a hundred stone Dutch; and so in proportion.

These particulars adjusted, the next thing the seller is to inform himself of, is the price of but-

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cher-meat in the market, of tallow, and of hides. Supposing the bullock I have to sell is seventy-two stone living weight, the four quarters make thirty six stone, which at 4 s. *per* stone, or 3 d. *per* pound, amount to L. 7, 4 s. The hide is worth 16 s. at 4 s. *per* stone; and the tallow, being 5 s. 4 d. the stone, is worth L. 1, 12 s. Sterling. The offals, according to the proportion above mentioned, will give 7 s. 6 d.; and by that computation the value of the bullock is L. 9, 19 s. 6 d. This answers to 2 s. $9\frac{1}{2}$ d. *per* stone living weight. And therefore, if the butcher agree to give me that sum *per* stone, no more is necessary to ascertain the price of the whole cargo, than to weigh the beasts by threes or fours as the scale can hold them. Out of this sum however must be deducted the butcher's profit, which cannot be much less than 5 *per cent*.

The weighing cattle alive answers another important purpose; which is, to discover whether the feeder gets the value of the food by the additional weight of the beast. For example, the food of a bullock costs 9 d. *per* day, or 5 s. 3 d. *per* week. If the bullock do not take on two stone *per* week, which seldom happens, the keeper is a loser; and there is no excuse for keeping the beast on hand, if it be not the expectation of a rising market.

There is another advantage of regulating the price of cattle by living weight. Where a butcher

cher buys by the lump, and bargains that he is to take away the beast at a day certain, the vender is tempted to be sparing of food. But supposing the beast to be sold by living weight, it is the interest of the seller to make it as fat as possible.

The same rule in selling is applicable to sheep. The four quarters make half of the living weight, the skin the eleventh part, the tallow the tenth part, the offals somewhat less than the third part. But computing the prices that these particulars sell for in the market, the amount will not be the value of the sheep, because the wool also must be taken under consideration. The wool from shearing-time to Lammas is of little value. At the end of December the value is by many understood to be half of the value of a full grown fleece; and upon that supposition, the following calculation is made. Yet there are not wanting expert dealers who value it much higher. They say, that in February or March, the wool begins to fork at the ends; after which it increases in weight, but little in value. A Linton, Ochill, or Lammermuir wedder, at the age of four, carries a fleece weighing at a medium two pounds eight ounces, valued at 9d. *per* pound when not tarred, which makes the value of a fleece at clipping-time, is $10\frac{4}{12}$ d. Sterling. At the end of December it is $11\frac{9}{12}$ d. *. Thus having a score of

* As the wool of sheep degenerates into hair in both extremes of heat and cold, smearing is a remedy in a cold

of wedders to sell at the end of December, each of which weighs six stone fourteen pounds Dutch weight, I want to know what they are worth *per* head.

1. The four quarters weighing 55 pounds, is, at 3d. *per* pound, L. 0 13 9
2. The value of the wool as above 11 $\frac{1}{2}$ d. to which must be added 10d. as the value of the skin, *inde*, 0 10 9 $\frac{1}{2}$
3. The tallow being the tenth part of the weight, makes 11 pounds, which, at 4d. *per* pound, is 0 3 8
4. The offals are not sold by weight, but are commonly valued at 0 1 0

The sum, L. 1 0 2 $\frac{1}{2}$

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cold climate. It also kills vermin, and makes a sheep take on fat five or six weeks sooner than it would do otherwise. Some miles round Cheviot hills, none but sheep of a year old are smeared: elder sheep are reckoned sufficiently strong to endure the cold without it. But there black sheep of all ages are smeared, because black wool is not discoloured by smearing. In the north of Scotland smearing is not known.

Wool shorn immediately after a sheep is washed, never turns white. A kind of oil, termed *gleet*, perspires from the animal, and contributes to whiten the wool in scouring. Therefore, where washing is necessary, delay shearing for a fortnight, that the wool may again be covered with gleet.

This price answers to 2s. 11 $\frac{6}{12}$ d. Sterling per stone living weight. And if the butcher agree to give that price, the value of any particular beast may be determined by weighing him as above.

From this must be deducted the butcher's profit at 5 per cent. or under, as can be agreed.

N. B. An animal weighs more or less as his belly is more or less full. The above proportions were made out when the sheep and horned cattle were weighed at eleven o'clock forenoon.

HAVING discussed cattle, I proceed to corn. The variety of measures in selling and buying corn, has been time out of mind a just cause of complaint in Scotland, as well as other countries; and it is indeed an inlet to many frauds. And yet, were all the measures used in Scotland reduced to the Linlithgow standard, there would still remain a great inconvenience in selling grain by measure; for of all commodities, it is the least proper to be sold in that manner. The quality of grain differs widely in different soils, and even in the same soil by good or bad culture. One boll of barley weighs eighteen Dutch stone, another only fifteen. One boll of oats weighs fifteen stone, another only eleven. The same difference is observable in other grain.

There is another objection against selling by measure. The slovenly farmer is satisfied with bulk,

bulk, without any regard to the quality of his grain : whereas, were it the rule to sell by weight, it would make the farmer doubly attentive to the dressing of his land, in order to produce the weightiest grain.

Beside weight, another circumstance enters into consideration for ascertaining the value of grain ; which is, the proportion of the husk to the kernel.

Middling wheat weighs *per* boll fourteen Dutch stone ; of which the husk makes the seventh part, or two Dutch stone.

Middling barley weighs *per* boll eighteen Dutch stone ; of which the husk weighs one stone four pounds.

Middling oats weigh *per* boll fourteen Dutch stone, of which the husk weighs six stone.

Middling beans weigh *per* boll fifteen stone eight pounds Dutch weight, of which the husk weighs but eight pounds.

And the same proportion holds as to pease.

C H A P. X.

CULTURE OF OTHER PLANTS, PROPER FOR A FARM.

THERE are many useful plants propagated by curious farmers that do not answer for food. I confine myself to three, the most common,

mon, and at the same time the most useful; forest-trees, flax, hops. I begin with forest-trees, as the most complex.

S E C T. I.

F O R E S T - T R E E S.

CONSIDERING the great quantity of waste land in Scotland, fit only for bearing trees, and the easiness of transporting them by navigable arms of the sea, one cannot but regret the indolence of our forefathers, who neglected that profitable branch of commerce, and left us to the necessity of purchasing foreign timber for every use in life. The Commissioners of the annexed estates, deeply sensible of this neglect, have bestowed liberally to rise plantations every where in the King's estates. Their laudable example has animated many land-proprietors, to benefit themselves and their country by the same means. The spirit of planting is roused; and there seems little doubt of its spreading wider and wider, till this country be provided with timber for its own consumpt at least, if not for exportation. As an author, I am fond to keep up that spirit: and in that view, the present chapter on the culture of forest-trees, will, I hope, be well received. A regular treatise upon the subject would require a volume: but as I must contract what I have to say within the

the nutshell of a chapter, I shall study brevity, and mention nothing but what appears material.

Trees are propagated by seed, by cuttings, by layers, and by suckers.

I. RAISING TREES BY SEED.

THE propagating trees by seed is nature's method. One inconvenience it has, that the trees thus raised are not always the same with the parent plant: though they are of the same species, they copy not always its varieties.

What follows will enable us to judge of the maturity of seed. Seed inclosed in a *capsula*, in a pod, or in a cone, is ripe when the covering opens by the heat of the sun. The seed of a fruit-tree is ripe when it no longer adheres to the fruit; and where unripe fruit is pulled, the seed ripens with it. In general, seed is ripe when it sinks in water to the bottom.

The seed of the Scotch elm ripens before the middle of June. The best way of gathering it is, to shake the tree gently: the ripest seed falls first, which may be gathered in a sheet laid at the root of the tree.

The seed of the ash and of the maple may be put into the ground without being taken out of its *capsula*.

The best way of opening the cones of pine, fir, &c. is to expose them in boxes to sun and dew.

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The drying them in a kiln is apt to destroy the germ. The cones of the *larix* are at their full size in autumn; but the seed is not so early ripe. Delay gathering them till March or April, when they begin to drop from the tree. Cut off a part of the cone next the stalk, which will render it easy to separate the quarters: the ripest seed falls out upon shaking the cone with the hand.

The seed of the birch, the willow, the poplar, the *aller*, being very small, is not easily gathered: stir the ground about these trees, and it will soon be filled with young plants. With respect to the seed of the birch and ash, it is singular, that when dropt from the tree, no seed takes root so readily; yet when gathered, and scattered with the hand, it seldom grows.

As for a choice of seed, small acorns gathered from large and lofty trees, are preferable before the largest acorns of smaller trees. In general, the seed is always the best that is procured from the most vigorous trees. But as in extensive plantations much precision cannot be expected, it ought to be the chief care that the seed be perfectly sound.

Next, as to preparing seed for sowing. Trees propagated from seed have all of them a tap-root, which pushes perpendicularly downward. The purpose of nature in this root is, to fit trees for growing in the stiffest soil, and to secure them against wind; but it proves hurtful to trees in-

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tended for transplantation. A young oak five or six years old, when taken up for transplanting, has, like a turnip, but this single root, which will be four or five feet long when the stem is within one foot. Planted in this manner, it seldom lives. This evil is prevented by making the seed germinate in moist earth, and sowing it in the seed-bed after the radicle is cut off. The radicle never pushes more; and instead of it the tree pushes out many roots, which spread horizontally. Walnuts, almonds, and other shell-fruit, being long of germinating, ought to be put in moist sand, in order that the radicle may push before the end of April, to be cut off as aforesaid. Acorns, Chestnuts, and beech-mast, will germinate timeously in dry sand. In wet sand or moist earth, they would, before the time of sowing, not only germinate, but push out long roots, which would ruin all. As this method is too troublesome for small seeds, sow them in beds as gathered: pull them up the second year: cut off the tap-root: and plant them again at the distance from each other of three or four inches. Two years after, they may again be transplanted wider; there to remain till they be fit for the field. Some imagine, that to deprive a tree of the tap-root prevents its growth. But experience vouches the contrary. And so does reason; for it is observable, that the roots next the surface, being accessible to sun and moisture, are

are always the most vigorous, and are farther spread than those below. A tap-root is deprived of sun and air, and even of water, unless where it happens to glide below the surface: how then can it equal a horizontal root in nourishing the tree?

The seeds of the white thorn sown without preparation, rise not till the second year. If buried under ground in a heap till the pulp be rotted off, and sown in the spring following, they will germinate that very year. Instead of burying them under ground, a more approved method is, to lay them in a heap at the end of a barn, mixed with earth. By that method, a greater number will germinate than in the ordinary way. I made an experiment. One bed was sown with haws prepared in the ordinary way; and one with haws prepared in the other way. Upon the latter bed sprung a double quantity of thorns, and more vigorous. I made another experiment upon elm-feed. Of a quantity gathered when ripe, the half was immediately sown; the other half was carefully dried in the shade, and sown a fortnight after. The latter produced a greater number of plants, and more vigorous. Thorns are propagated still more expeditiously by cuttings from the root. When thorns are taken from the nursery to be planted in a hedge, the roots that are either wounded by the spade, or too long, must be cut off. Let these be shred into small parts, and sown in a bed prepared

prepared for them: they will produce thorns that very year. The seed of the ash seldom germinates till the second year: when gathered in the month of October, let it be put in pots with earth and sown in the spring: it will germinate immediately. The ordinary way of raising hollies, is to sow the berries entire; which is wrong: every berry contains four seeds; and the plants that spring from them are so interwoven, as not to be separable without injury. A better way is, to gather the berries in December, the later the better, if they can be saved from birds. Throw them into a tub with water, and between the hands rub them carefully in the water till all the pulp fall off. The good seed will sink to the bottom, which, after the water is poured off, must be laid upon a cloth to dry. Mix them with dry sand, which will preserve them all winter. Sow them in March or April, and cover them with earth about three quarters of an inch thick.

With respect to the time of sowing, the best rule is, to imitate nature, by sowing when the seed is ripe; provided the tree be of a hardy kind to endure the frost of winter. By this rule, the seed of Scotch elm ought to be sown in June; the seed of pine and fir in April, at which time their cones open. Acorns, chesnuts, and beech-mast, ripen in autumn, which is the time of sowing them. If they ripen later, it is more safe to sow

sow them in the spring following; because the young plants cannot resist frost, if before winter they have not acquired some degree of vigour. There is another reason for storing up these seeds till spring; which is, that the longer they lie in the ground, the greater risk they run of being destroyed by vermin. As the white thorn vegetates early, the haws ought to be sown the first dry weather in February, after being separated by a wire-sieve from the mould with which they were mixed. Avoid fresh dung, which is injurious to them. Sow the seed of the *larix* when taken out of the cone in March or April; for though in the cone it will stand good for years, yet it does not long retain its vegetative quality when separated from the cone.

Next, as to the manner of sowing seed. Nature drops seed upon the surface of the ground. We must depart from nature in this instance, upon the following account, that after much expence and trouble in procuring seed, the far greater part would perish, partly by vermin, and partly by inclement air. This is not regarded by nature, which is profuse in the production of seed. All seeds therefore ought to be covered with earth, birch-seed alone excepted, which ought to be pressed down with the back of the spade, but left open to the air without covering. Small seeds must be slightly covered, as having
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less vigour to push upward *. In strong soil, the covering ought in every case to be slight. The depth is pretty much arbitrary, because the same seed will thrive at different depths. But it must be attended to, that a slight covering exposes the seed to drought; and therefore the ground ought to be watered if the season be dry. Where the ground sown is too extensive for watering, a crop of barley will preserve the tree-seed from the sun, and also prevent weeds. The tree-seed and the barley may be sown alternately in lines. If trees are intended to remain where their seed is sown, it is proper to sow thick, partly for shelter, partly to keep down weeds. M. Buffon declares against weeding the ground upon which the seed is sown: "For," says he, "weeds shelter the young plants from the sun, keep in the dew, and preserve the plants warm in winter." In Scotland nothing is more hurtful to plants than weeds, which choke them, and exclude air. A better

* As a slight covering exposes the seed to drought, watering is commonly used if the season prove dry. But the surface by such watering is apt to harden and to prevent the tender plants from springing. It is easy indeed to break the crust by a harrow or rake; but this lays the plants open to be destroyed by the sun. A method that has been used with success, is to cover the seed half an inch deeper than ordinary; and from time to time to remove part of the covering. The surface by this means being rendered loose and free, will be a kindly invitation to the young plants to push upward.

better way, even in France, is to sow barley with the seed, which will protect the young plants from the sun, and admit air.

The best way of preserving seed is in dry sand, which sucks in the moisture from the seed, and prevents mustiness. It withal retains so much moisture as to prevent the seed from withering. This method is chiefly useful in preserving during winter seeds that require spring-sowing, and in the conveyance of seeds to a distance. The efficacy of dry sand appears in preserving oranges and citrons, which in the air dry and wither : if to prevent withering they be laid in a moist place, they never fail to turn musty. There is one exception, that seed which lies long in the ground before it germinates, ought to be preserved in moist earth. The seed of the sensitive plant will keep entire for twenty years ; of a melon for nine or ten. There are many seeds that will not keep entire longer than two or three years ; which is the case of flax-seed, though remarkably oily : some seeds require to be put in the ground as soon as ripe.

To prevent young plants in the seed-bed from being spewed out by frost, cover the beds with leaves of trees, to be removed when the severe frosts are over.

We proceed from the seed-bed to the nursery. Plants form very different roots, according to the soil they grow in. In stiff soil, the roots are commonly

monly few, but strong and vigorous for overcoming the resistance of such a soil. Roots multiply in proportion to the richness and mellowness of a soil. An oak, for example, has a strong tap-root, which fits it, more than any other tree, for growing in a stiff soil. This root diminishes in strength and size in a loam, and still more in a sandy soil. When it grows in water, it has a multitude of roots, but not the least appearance of a tap-root. Hence it follows, that the soil of a nursery ought always to be light and free : such a soil produces a multitude of roots ; and the vigour of growth is always in proportion to the number of roots, the smaller the better. But it also follows, that in transplanting trees from such a nursery, the soil about them ought to be made as mellow and free as possible, in order to encourage the small roots. When these are enlarged in so fine a soil, they will be able to overcome the stiffness of the natural soil of the field. Avoid dung in a nursery. If any be admitted, it ought to be thoroughly putrefied, and digested into a sort of rich mould. Green dung makes the roots ill conditioned, and encourages a large white worm, which lives on the bark of the roots. Neither the walnut nor horse-chestnut succeed in a nursery : the plants require to be placed at a distance from each other ; and the earth about them must be stirred several years. Aquatics that are intended to be propagated by large

large cuttings, ought first to have the benefit of a nursery; because they thrive best when planted out with roots. Avoid a mixture of different trees in the same bed, for the slow growers will be oppressed.

The true season for transplanting from the seed-bed to the nursery is about the fall of the leaf. Catch the time when the earth is so moist as to suffer the plants to be drawn without tearing the roots. All evergreens ought to be transplanted in spring; and also all other trees that suffer by frost.

Where trees are so young as that an interval of five or six inches along the rows is sufficient, there must be an interval of a foot at least between the rows, in order to give access to clean the ground of weeds; and this interval is sufficient, even when the plants are so large as to make an interval of a foot along the rows necessary. Where the distance along the rows is made eighteen inches, or two feet, the intervals between the rows ought to be no less, for the sake of the trees, though unnecessary for the sake of weeding. Yet such is the influence of custom, contrary to common sense, that from the original position of young plants in a nursery, the interval between the rows is always made double of the interval along the rows. Thus if the latter be eighteen inches, the former is always made three feet; and four feet where the size of the trees requires

an interval of two feet along the rows. The same influence of custom occasions trees to be planted in rows in the field, where they are to stand; and yet they make a much better figure when, in imitation of nature, they are scattered as at random. •

The pruning young trees in the nursery is an article that deserves attention. Lateral branches that are like to get the better of the stem, ought to be retarded in their growth by being pinched more than once during summer: and where the lateral branches are too frequent, they ought to be thinned. This practice promotes greatly the growth of the stem. The like good effect will follow from treating in the same manner, for two or three years, young trees after they are planted out. Thus managed, they will for ever after need very little pruning.

2. CUTTINGS, LAYERS, SUCKERS.

SEED is not the only means that nature has provided for propagating trees. They can be propagated by cuttings, by layers, and by suckers. They have one advantage, that whereas seed propagates the kind only, these carry on any variety in the tree from whence they are taken. Grafting has the same effect.

The willow, the osier, the vine, the elder, the poplar both black and white, the platanus, the yew, the box, may all be propagated by cuttings.

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The black poplar is singular: a branch will not answer for a cutting, unless the top be left entire. A cutting of willow eight or ten feet long, and seven or eight inches thick, planted in the following manner, will soon become a tree. Let the great end be immersed in water a foot deep as soon as cut, which ought to be the end of March; and remain in that state till planted, which ought to be the beginning of May. Immediately before planting, cut the great end sloping to a point; and on the side that is not cut, keep the bark entire down to the point. Make a hole in the earth a foot and a half deep, sufficiently large to admit the cutting without ruffling the bark, which would prove destructive. Any vacuity left in the hole must be filled up with fresh earth, and pressed down close to the cutting. A safer way, and little less expeditious, is to make the hole with the spade, to return the earth to the hole round the cutting, and to press down all firm and close. After standing a year, throw some fresh earth upon the roots. It is still better, to make a ditch two feet from the row of the trees thus planted, and to lay upon the roots the earth of the ditch. Several trees that can be propagated by cuttings, require more precaution than the willow or poplar. The branches intended for cuttings must be young; and a part of the greater branch from whence they are taken must be cut with them, to serve as a sort of root. With all these

these precautions, it must not be expected, that every cutting from the platanus, the white poplar, the poplars of Virginia and of Lombardy, the aspin, the maple with ash leaves, will take root. Cuttings from the yew, the alaternus, the box, require the utmost care. They ought to be planted in beds sheltered from the sun, and watered in dry weather.

All trees do by layers ; and the method is easy in shrubs which have branches near the ground : but to propagate by layers from large trees that have no branches near the ground, such as the lime, the mulberry, the aller, more art is necessary. One method is, to cut the tree by the ground before the sap begins to rise ; which will produce many shoots the first year. The next year at the same time, heap earth upon the root till it rise a foot upon the shoots. After two or three years remove the earth, and cut off the shoots, which will be full of roots as far as they were covered with earth. These will make good plants. Spare the smaller shoots, and cover them with earth as before : they will in time produce new plants. By the following method, the shoots may be so managed as to produce young plants without end. Toward the end of February, bend the best shoots down to the ground, twisting them a good deal about the middle, and covering that part with earth. Set the ends upright to be preserved in that posture by earth pressed about them.

them. A shoot by being twisted, will produce more roots the first year, than otherways in two or three. Every shoot thus laid, will produce several shoots ; of which layers may be made, managed as above-mentioned. A third method is, to chuse a young tree eight or nine inches in circumference ; and cut it over two feet from the ground. In every part, the stump pushes many shoots. The second or third year, take all out of the ground : lay the stump with its roots and shoots in a trench ; and cover them with earth, so as to leave nothing open to the air but the extremities of the shoots. These will thrust out roots under the surface, which will afford young plants in abundance. When a pine or a fir is cut down, the root dies without producing any shoot. Nor can these trees be propagated either by cuttings or by layers ; if a spruce fir be excepted, which it is said can be propagated by cuttings.

To have straight trees, cuttings and layers ought to be of perpendicular branches, especially where the wood is hard. How long layers should continue in the ground to have good roots, depends much upon the season, and still more on the nature of the tree. A bramble will take root on the surface of the ground, without the least covering of earth. Layers of lime and of platanus have commonly good roots in three years, and

and sometimes in two. Many trees require longer time.

To propagate by suckers, part of the root of the parent plant must be cut along with the sucker. It must be immediately planted in a nursery, in order to acquire roots. When planted out to stand, the old root should be cut away all but what is close to the sucker; for it is apt to swell under ground, and to obstruct the growth of the plant. To have a quantity of suckers, which rise not plentifully from old trees, cut the old tree over, and the ground will be filled with them. Some writers say, that trees propagated by layers take on a better shape, and grow faster, than those propagated by suckers.

3. SOIL PROPER FOR TREES.

THE soil proper for trees comes next in order. Fat sand, that is, clay mixed with a large proportion of sand, agrees with almost every sort of tree, especially if the soil be deep. Evergreens do well in such a soil. And even aquatics, such as ash, poplar, willow, alder, thrive in it, though more slowly than in moist ground: these aquatics make a shift even in ground too dry for the oak, the beech, the chestnut. A pine grows well in sand. The juniper will grow in a very thin soil where scarce any other tree will thrive. An aspen does well in a pure clay: a chestnut does not. Dry earth

earth of a good quality, though but eighteen inches above a tough till, will bear the elm, the maple, the horn-beam, the walnut, the ash, the birch, the mulberry, the white poplar, and almost every kind of shrub. If but ten or twelve inches deep, it is only fit for shrubs; excepting the birch, which will grow if the till be covered with but five or six inches of black and light earth. The lime and the horse-chestnut love a tender and deep soil. Marshy soil is proper for the willow, the ash, the aller, the occidental platanus, and for most sorts of the poplar. An elder, though it makes a shift in the driest soil, yet loves moisture; and therefore is proper for a fence on the sides of ditches, for cattle do not touch it. Ground elevated two or three feet above a running water, being moist without being marshy, is fit for trees of every sort, particularly for the occidental and oriental platanus, the tulip-tree, and the lime. Young trees should be planted differently, according to the nature of the soil: in a soil retentive of moisture, the tree should be bulked above the surface; in a very dry soil, the earth round the tree should slope down to the root, in order to collect the rain. In general, though corn prospers in clay, sandy or gravelly soil is fittest for trees. The culture of corn, renewed annually, renders clay open and free; but when left untilled, it turns too hard even for the roots of trees.

4. CLIMATE.

WITH respect to climate, an oak is an inhabitant of the temperate zone : none are found between the tropics, and none farther north than Stockholm. Fir and birch bear much cold, the latter especially. Plants, like animals, after several generations, come to thrive in a climate very different from their own. It requires peculiar skill and attention to habituate to a new climate such as grow on the top of the Alps, and on the top of high mountains farther north. Their nature fits them for a very cold summer ; and for a temperate winter, being always covered with snow during that season. In a low country the want of snow can be tolerably well supplied by some small degree of artificial heat ; but in our summers it is not easy to give them the cold of their native place.

The advantages and disadvantages of different exposures come under the present article. In spring, even a strong frost hurts not plants, provided the ice be melted before they are exposed to the sun : but even a moderate frost commits great waste, if the ice continue till it be melted by the sun ; for the ice acts as a burning-glass. By that means, delicate plants, exposed to the rising sun, are often destroyed in spring ; while such plants, exposed to the north, are safe : which is the

the fate even of young shoots of the oak. An eastern exposition has, on the other hand, its advantages. Plants are sooner relieved from the morning cold by the heat of the sun : they are protected from the sun's meridian heat : and as the east wind is generally dry, spring-frost makes less impression than where there is more moisture.

In a southern exposition, plants, being covered from the north, are the less subject to frost. As the sun reaches them not till about ten in the morning, the spring ice is commonly melted before that time ; and if the climate be rainy to temper the meridian heat, trees in that exposure grow fast. The disadvantages are, first, that young plants are apt to be scorched by the sun, especially in a light soil and dry summer : next, that ice is frequently melted in that exposure even by winter-heat ; and if the moisture be not sucked up by heat or dissipated by wind, it congeals in the evening, and does much hurt.

A western exposition is free from the burning sun in a dry season ; but is exposed to spring snow and hail, which come mostly from the west. We often feel a west exposition insupportably cold, when the air is tolerably soft in other expositions. Hardy trees can bear this cold ; but tender trees are often destroyed by it.

In a northern exposition, snow never melts ; and the wind from that quarter is the coldest and driest of any. By that means however per-

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spiration

spiration is so faint, that little moisture is required. Here deciduous forest-trees grow slowly; but the pine, the fir, the yew, the evergreen oak, the box, and the other evergreens, thrive well. This fact appears singular: evergreens perspire little; and one would think that they should, more than other trees, need the action of the sun to keep their sap in motion. The birch also thrives well in a northern aspect. In a dry and light soil, trees thrive better exposed to the north, than to the south: in the former, the dew continues on the trees till nine or ten in the morning; and the sun strikes not so violently as to wither the ground, or to occasion great perspiration. But a southern aspect merits the preference in a clay soil, and in a cold climate.

5. TIME OF PLANTING TREES IN THE FIELD.

WITH respect to the time of planting trees where they are to stand, it runs from autumn when they drop the leaf, till spring when the buds begin to swell; provided it be fresh weather, and the ground be tolerably dry. But because in the dead of winter frost prevails, or too much moisture, two seasons chiefly are recommended, namely autumn before strong frost sets in, and spring after it is past. In this season, planting may be continued till the buds begin to open; which

which in some trees is early, in others late. The opening the buds depends also on the season, late or early. Whether autumn or spring be the best for planting is not agreed. As the weather is commonly moist in autumn, trees brought from a distance suffer less in that season by being long kept out of the ground; and if the winter happen to be mild, new roots are produced, which are a fine preparation for a more vigorous vegetation in spring. Millar holds October to be the best season for planting trees that lose the leaf in winter, provided the soil be dry. In a moist soil, it is better, says he, to defer planting till the latter end of February or beginning of March. But though this may hold in general, there are several exceptions. Tender plants that are hurt by frost, ought to be delayed till spring. Trees that retain the leaf during winter, ought to be transplanted in spring; for, having a slow circulation of sap, they perspire little, and run less risk of being hurt by drought. Another reason concurs with respect to the oak, the beech, and the hornbeam, which hold the leaf all winter: the reason is, that they are late in pushing; and when planted in February or March, they have time to prepare new roots before the buds begin to swell *. April is undoubtedly the best season

* It is maintained by some writers, that the best season for planting oak and larch, is immediately before the buds begin to push. I have not discovered any good reason for making these trees an exception from the general rule.

season for evergreens; though they may be safely removed at Midsummer, if near the place where they are to stand. During winter evergreens are in a state approaching to rest. If removed at that season, they do not take root till the spring sets the sap in motion; and in a hard winter they commonly die. Light land should infallibly be planted in autumn; for spring-planting in such land is subject to great distress from the summer-sun.

6. MANNER OF PLANTING.

As to the manner of planting trees in a field, the safest way to draw them out of a nursery for planting, is to remove the earth from the first row of trees, which by that means will be easily drawn without hurting the roots; proceeding in the same manner till all be taken up. What are too small, may be planted in a new bed prepared for them. For three years after trees are transplanted from the nursery, the ground about them ought to be twice stirred annually. Once a year after will be sufficient, till the trees get entirely the better of weeds. Plantations weeded for a year or two only, have visibly languished. As soon as trees thus cultivated begin to join their branches, the lower branches fall off, and the weeds are smothered. This is the time of the most vigorous growth. Trees cannot be planted too thick, provided attention be given to thin them

them timeously. Thick planting shelters them from wind and from cold. When they rise to seven or eight feet height, so as to wave with wind, they ought to be thinned, to prevent their rubbing upon one another, which is apt to create a sort of gangrene. But let them be thinned cautiously: shorten the branches of the weakest tree, for giving room to the trees that are to stand; and let that tree be cut down a year or two after. This is a better method than to cut down the tree at first; for young trees that have too much room, are apt to branch out instead of pushing up. This method does finely in a plantation of firs and pines. When the trees rise to eighteen or twenty feet, and by good roots are proof against wind, they ought to be much thinned, so as not to leave one nearer another than its own length. Where trees of that height stand close together, they occasion a stagnation of air: the air they suck in is unwholesome, and makes them languish. Young trees five or six feet high only, occasion very little stagnation of air: the free air above mixing with that below, preserves all sweet and wholesome.

Free air is necessary for plants as well as for animals. People crowded together in a great town, lose vigour and become diseased. For the same reason, trees planted thick, wither and lose their growth. Of this, there are examples without number in Angus and Mearns. We see
every

every where clumps of firs, many that have stood thirty or forty years, without lateral branches, not a leaf but at the top where the air is free; the outer rows where the air can penetrate, tolerable; of the rest of the clump, within, not one tree bigger than a man's leg. Yet, in no other part of the world can there be a stronger inducement to thin trees; not only to procure timber, which is much wanted in that country, but to procure a still more useful commodity, and that is fuel; which is so scanty in that populous and manufacturing country, that for an acre of broom of five years growth, L. 5 Sterling is an ordinary price. Yet the proprietors in other respects, are careful of their affairs. It is not in my power to find a meaning. Suppose a field of fine wheat is suffered to rot on the ground, without ever applying the sickle; would it not be justly concluded, that the farmer is crazy? Is there no reason to apprehend the same imputation upon gentlemen, who, after the expence of fencing and planting, look on and suffer their plantations to go to ruin, by neglecting to apply the axe? I have often censured this supine negligence, as not only hurtful to the proprietors, but to their manufactures. I willingly embrace this opportunity of public admonition, hoping it may prove more successful than private censure.

One method of making a plantation turn to profit in a short time, is to begin with planting
birch

birch in rows with intervals of six feet, stirring the ground about them two years. In the intervals sow acorns, chefnuts, or beech-mast. The birch, a fast grower, will in a few years form a thick wood, destroy the weeds, and shade the young plants below them. The birch cut out when they begin to oppress the trees under them, will afford some profit, and leave the ground plentifully stored with better trees.

The best way to encourage trees planted in a row, is to draw a trench at the side of the row, at such a distance as not to wound the roots. The earth thrown upon the roots will save weeding, and secure the trees against wind. The water in that trench will be an additional nourishment to the trees.

Evergreens, perspiring less than other plants, require less nourishment, and for that reason continue green all winter. They resemble the exanguous tribe of animals, the frog, the toad, the tortoise, the serpent, which, perspiring little, make a shift to pass the winter without food. Evergreens, by perspiring little, have a thick, viscid, oily sap, which enables them to endure the winter's cold. They seem many of them to thrive best in the temperate seasons of the year; not so well in the heat of summer, their perspiration being then too great for the slow ascent of the sap. Evergreens, when transplanted, do not so readily strike root as other trees: for
which

which reason they ought to be taken up with a bulk of earth about their roots, Gardeners commonly place shrubs of this kind in an osier-basket, which soon rots after it is put into the ground with a tree. A holly thus transplanted ought to be watered in the month of May, if the season be dry.

In order to transplant a tree with a bulk of earth about the roots, cut a trench round it at the distance of ten or twelve inches, as deep as the roots go, cutting over with a sharp knife all the roots that appear. Return the earth into the trench. Repeat the operation next year, but a little farther from the tree. When the tree is transplanted the year after, the roots will be so interlaced in the bulk, that none of the earth will fall away in carrying. The hole where the tree is to stand, should be considerably larger than the bulk, and made some months before planting, to receive the influence of sun, rain, and frost. Fill up the hole with fresh good earth, fit to encourage the young roots. The harder the soil is, the hole ought to be the larger, to receive the greater quantity of the nourishing earth. In making the hole, lay the upper *stratum* on the one side, and what is below on the other: lay the former about the roots, being the best soil, and cover it with the latter. Preserve as many roots as possible, shortening those only that are too long, and what are torn in taking up. If the

the tree have too much head, shorten the largest branches, leaving the small branches for carrying leaves: it is by these that the sap is drawn up; and it is by these that perspiration is performed. But preserve carefully the leading shoot or shoots; for many experiments have made it evident, that these have the greatest power to draw up the sap. If the lime be not an exception, a tree, after its head is lopped off, spreads into a bush, but never rises in height. Conclude all, by pressing down the earth vigorously with the foot. A tree planted deep in the ground, stands the firmer against wind: its roots are better protected against sun and frost, and less apt to throw up suckers. These considerations notwithstanding, trees ought not to be planted deep; for they languish till they acquire roots near the surface. These, spreading themselves in the best soil, and being accessible to sun and rain, convey much more nourishment to the tree than those below. Nothing however is meant against planting large trees deeper than what are small. At the same time, if the under soil be bad, or very moist, even large trees ought to be planted near the surface, with a bulk of earth about them. Because in a porous soil the sun penetrates deeper than in clay, and withers the roots near the surface; for that reason a tree ought to be planted deeper in the former than in the latter. Many think, that a fir does best where fir-trees have been recently cut:

a fir being the native of a cold country, stands much in need of a shade in summer; and therefore succeeds the best when protected from the sun by surrounding firs. So far the observation holds, and I believe no farther.

It ought to be an indispensable duty, to visit young plantations after every high wind, and to set upright those that are shaken, pressing the earth close about the roots. Support a tree much shaken with a forked stick. I know no general rule more important than this. It is my opinion, that more trees are lost by neglect of this operation, than any other way. The operation ought to be renewed after every high wind, till trees have acquired such roots as to stand firm against wind.

Some are careful, to give a transplanted tree the same position with respect to the sun, that it had in the nursery. But experience has proved this precaution to be useless.

As the expence and risk of filling up a vacant spot with a full-grown tree is great, a nursery may be set apart for rearing young trees till they be from fifteen to eighteen feet high. These trees may be transplanted twice or thrice in the nursery for multiplying their roots; and they ought to be planted where they are to stand, with as much as possible of the nursery-soil about the roots. In that view, frost is the proper time for the operation. Such trees will not at first make

so great a figure as full-grown trees ; but there will be less hazard of miscarrying.

Where trees of unequal growth are planted together, the quickest growers will overtop the rest, and destroy them. Therefore let trees of the same kind be planted in clumps ; or let none be mixed but what grow equally fast. I imagine there is a beauty in small clumps, as it makes different shades the more conspicuous. Colours, even the finest, make but a faint impression in a confused mixture.

7. PRUNING.

AND now of pruning. By multiplied experiments it is ascertained, that the cutting off young branches, hurts not any sort of tree, not even the walnut, nor the resinous kind. The lowest branches, which in time would wither and drop off, ought first to be cut ; but gradually, that the tree may not be bared of leaves. Severe pruning makes trees grow tall, but withal so slender as not to resist wind. Every tree suffers by having its large branches cut off, but in different degrees. The wound of an elm is soon healed : not of a walnut, an oak, or a pine ; if the tree be not vigorous, the wound is apt to rot into the body. When a large branch is cut off, though the place of its insertion is soon covered with wood and bark ; yet the new wood doth not unite with
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the old, and there always remains a defect within. When an overgrown branch is cut close to the trunk, which ought to be at the end of the year, the young shoots must the next June or July be pulled off with the hand. If cut off with a knife, shoots will grow without end, and create a disfiguring bunch in the tree. A writer, whose integrity equals his experience, affirms, that a branch cut some inches from the trunk will make no blemish in the tree *. The greatest attention ought to be given to the head: if forked, one of the rival branches must be cut off six inches high; and to the remaining stump ought to be tied the other branch, in order to give it an upright direction. If a young tree become stationary, as it is apt to do in stiff soil, cut it over by the ground in September, or rather below the ground. Next June or July tear off with the hand all the shoots but the strongest, and lay earth round the stump. If this be delayed till the sap fall, there is danger of tearing the bark of the stump, which would hurt it. Avoid a knife; for at every amputation shoots will push, which must again be cut, and a bunch will grow. Instead of cutting by the ground a young tree become stationary, some recommend a slit in the bark from the root upward. A trial was made of these two methods in the same field; and those that

* Kennedy.

that were slit became the most thriving trees. The experiment was made upon ashes.

Pruning may go on from the beginning of July till the middle of September: trees later pruned suffer by cold. A holly is an exception: it has a large heart, and is hurt by frost if clipped or pruned after the month of July. A holly-hedge, that was not clipped after the month of June, endured without hurt the hard frost of the year 1740.

The Scotch fir, which is not a fir but a pine, deserves to be cultivated for beauty as well as for use. In a natural wood, the timber is always better, and freer of knots, than in a plantation. Trees are always planted at the same time; but in a natural wood are of different ages, the elder bearing down the younger, but not without losing all their under branches. This in effect proves a benefit; for as the under branches do not spring again, there happens to be much timber without knots. In a planted field, on the contrary, the trees grow all equally; and if weeding be neglected they grow up like spindles without a lateral branch: if duly weeded, so as to give room for lateral branches, the lower branches die by degrees, and leave knots in the trees. Therefore to train a fir-plantation, the trees ought to be thinned as soon as they begin to wind-wave; and the lowest tire of branches should be cut off from every tree that is intended to stand. Another tire should be cut off the
next

next year; and so on, leaving five or six feet of the trunk without a branch. All the wood that is added to the tree after, will be solid without a knot. A better way is, to tear off with the hand the under branches, which bring their roots with them: the hollow is soon filled up with regular fibres, and the wood is all equally good. A branch cut away with a knife, though close to the stem, leaves its root, which becomes a knot when surrounded with new wood. If a Scotch fir be intended for beauty, let all other trees be kept at a distance, and it will stand forty or fifty years without losing a branch. Travelling in Northumberland, Durham, Yorkshire, clumps of Scotch fir are seen advantageously planted on knolls. But never an attempt to weed. They are in the high way to destruction for want of air and room. When a larch is fifteen or sixteen feet high, cut off the lowest tire of branches in October close to the stem, and the next two tires successively, year after year. The rays of the sun will be admitted to the root of the tree; and the air will have a free circulation, necessary to all plants. It will not be necessary afterward to use a knife to a larch, unless it be to lop off a broken branch*.

Sheep

* In Mr Duff's garden, town of Ayr, there was an old stump of a thorn three or four feet high, that appeared to have very little life in it. It was pierced in several places with an iron nail: buds came out at every hole; and now it is a flourishing tree about fifteen feet high.

Sheep and goats are more destructive to young trees than horned cattle; and these, more than horses. Sheep are fond of the leaves of the white thorn, above all other food: it is folly to think of white-thorn hedges, without banishing them. The depredations of these creatures upon my plantations, have often swelled my heart against Providence. Why has it made young trees so palatable to them: what woods might not be raised, were it not for the expence of fencing! Such thoughts were apt to steal in upon me. But in nothing are we more in the wrong than in murmuring against Providence. It is to us a signal blessing that domesticated animals feed on young trees: otherwise, the utmost industry of man would be insufficient to prevent trees from occupying the whole ground, and putting an end to agriculture; he would be reduced to his original savage state.

8. WOOD PROPER FOR INSTRUMENTS OF HUSBANDRY.

AMONG the most expensive articles of a farm, are carts, ploughs, brakes, harrows, rollers, &c.: and it is of importance with respect to oeconomy, that these should be constructed of proper wood. To that end the following hints may be of use.

I begin with examining, at what age a tree is in perfection for the purposes of a farm. At the
age

age of sixty, it is sufficiently large for every farm-purpose; being, when cut to the square, from twelve to fifteen inches each side. I must except the oak, which, even for the purposes of farming, improves till it be a hundred years old. Every oak consists of red and white wood; the former the firmest of all wood, the latter good for nothing. Ash, after the growth of sixty years, turns short and brittle.

The proper season for cutting a tree is, when it has least sap; which is precisely in the middle between the time of shedding the leaf and that of budding: in that interval it is tough, and fittest for every farm-purpose. When cut in the sap, the wood is short, and apt to split with drought.

For preserving wood after being cut, there are three methods. One is, to dry it in the air; another, to immerse it in water; and a third, to cover it with horse-dung. Ash, when sawed green, never fails to split. Before applying an instrument, it ought to be exposed eighteen months in a dry situation, that all the sap may evaporate. During that time, both ends ought to be covered from the air: the bark prevents the body from splitting; but when the ends are exposed, they will split into the body five or six inches. When ash is designed for uses that require splitting, let it be split immediately after cutting, and the parts laid up where the air has not

not free access, in order that they may dry by slow degrees; for sudden drought makes them warp. Oak and elm require the same treatment. The Huntington willow, and other willows that rise to a large size, turn extremely tough when dry; and therefore, if intended for planks or boards, they ought to be sawed directly after being cut. But as in this case they are apt to split, great care ought to be taken to dry them slowly. Alder and birch ought to be managed in the same manner.

The immersing in water, and covering with horse-dung, are far from being the best methods of drying wood. It is always harder and tougher when dried slowly in the air. Therefore these methods are only for expedition, in order to extract the sap the more quickly when the wood is wanted for immediate use.

There is not an instrument of husbandry that consists of different parts, but requires wood of different kinds. Of all wood, oak is that which resists moisture the best, and can the best endure the being totally deprived of air. For these reasons, oak is the only wood fit for being mortised into other wood. From the part that is mortised, air is totally excluded; and yet some moisture finds access, being more penetrating than air. Therefore, the spokes of a wheel, which are mortised both into the nave and fillies, ought indispensably to be of oak; the sheths of harrows, which

bind the parts together, ought to be of the same wood ; as also the head of the chain-plough, because it is mortised into the beam. As ash is less apt to split than oak, it is more proper for naves and fillies. Being the toughest of all wood, and the most elastic, it is the fittest for the shafts of a cart. The best wood for the body of a cart or waggon, is the Huntington willow. It is both lighter and tougher than even the best red fir. The head of the Scotch plough may be of alder, because it is not mortised into any other part. Whatever the plough be, the mouldboard may be of willow, or alder, or plane ; because they are light, and not apt to split. The bulls of brakes and harrows should be of birch or alder. A roller should be made of beech-wood, being heavy ; the sheths and pins of oak, and the shafts of ash. Foreign fir is the best and cheapest for couples. Beech-wood would be still better, were it not apt to take the worm : but in a farm-house that is not lofted, will not the japanning with smoke prevent that evil ? The handles of spades, shovels, picks, &c. ought undoubtedly to be of ash : beside its toughness, it is less apt to turn warm in handling, than any other wood. For gates, fir is undoubtedly the best : It is light ; it resists moisture ; and is not apt to warp.

One general rule I give, of more importance than at first view may be thought, which is, that the angle made by mortising, or otherwise, being
always

always the weakest part of the instrument, ought to be fortified with a plate of iron fitting accurately the angle of the wood.

S E C T. II.

F L A X.

HAVING finished what I had to say on forest-trees, flax comes next in order, according to the distribution made above. The regulations published by the trustees for manufactures, have left me little to observe upon that article. I shall venture a few particulars only, more immediately connected with husbandry. Annual weeds abound so much in this country by careless management, that the weeding of flax is the greatest incumbrance on its culture. After horse-hoed turnip, cabbage, or potatoes, flax succeeds well; and I know no other crops that extirpate weeds so effectually. A potato-crop being removed in October, the ground during winter gets a frost-preparation; which cannot be obtained after cabbage or turnip, because these keep the ground all winter. Therefore, above all, I recommend a potato-crop as a preparation for flax. Next to it, if at all inferior, is pasture-ground three or four years old, left rough in foggage, and in that state trench-plowed before winter. It gets the frost-preparation, is clean of weeds; and the rough
foggage,

foggage, turned to the bottom of the furrow, retains moisture like a sponge, which it yields plentifully to the roots of the flax. Flax is a thirsty plant; and a better situation it cannot have for procuring nourishment.

In pulling flax, the fully ripe ought to be separated from what is less so, and the tall from the short: when mixed, they neither water well, nor dress well. Let the seed, when separated from the plant, be beat lightly and passed through a sieve. The best and plumpest will come out first; and this ought to be reserved for sowing again. Beat what remains with a heavier hand: the seed thus got will be fit for the oil-mill.

Lint pulled green requires less watering than when fully ripe.

S E C T. III.

H O P S.

THE last article of this kind I undertook, is the hop. A regular hop-yard is an undertaking too great for an ordinary farmer; but every farmer, by the following plan, may have hops of his own growing, sufficient for his own use, and perhaps for his neighbours. If I can reduce the expence within moderate bounds, I am not afraid of the climate of Scotland: many judicious

judicious trials made here, have produced good hops.

Dr Woodward has observed, that the fruit which grows nearest the ground, is always the best. This has suggested to me a thought, that hops may be propagated in the espalier way like apples or pears. Fix in the ground, at an interval of three feet, a number of poles eight or nine feet high, in a line from west to east. Beginning at the west end, plant a hop-vine at the foot of each pole, the last six or seven excepted. Instead of allowing them to ascend the poles, train them from west to east in an angle with the horizon of nine or ten degrees, and directing them from pole to pole by small twigs between the poles; observing to twist them round the poles and twigs as they grow naturally in ascending upon a pole: in the contrary direction they cannot be made to grow. In this manner, each vine may extend itself twenty or thirty feet, without rising at its extremity more than nine feet above the ground. If a hop resemble other fruit-trees, it will carry more fruit by having the growth of the wood checked. And if this method succeed, a small hop-plantation may be within the reach of every farmer, requiring some attention, but little expence. Poles above twenty feet long, renewed every two or three years, are a most expensive article in an English hop-yard; and the places in Scotland are few where they can be procured at any

any rate : but poles of nine or ten feet may be procured every where. There is another signal advantage of this method : Wind is a great enemy to a hop-yard ; but a row of humble poles bound together by hop-vines will be sufficiently secure against wind, especially in a line from west to east.

Taking it for granted, that the fruit next the ground is the best, I am in the course of an experiment with a young apple-tree having two branches, one trained to the west, the other to the east, upon small pegs of wood about six inches high. Under these branches the earth is covered with sharp sand, in order that the fruit may be benefited both by the direct and reflected rays of the sun. It deserves an experiment, whether hops may not be trained successfully the same way, without the expence of any poles. It will cost very little expence to fill a whole acre in that manner, making an interval of a foot or eighteen inches, in order that the sun may have access to all of them equally.

C H A P. XI.

M A N U R E S.

THE manures commonly used in Scotland are dung, lime, shell-marl, clay-marl, and stone-marl. Many other substances are used ;
shavings

shavings of horn, for example, refuse of malt, and even old rags: but as the quantity that can be procured is inconsiderable, and as their application is simple, I shall consume no time upon them.

Dung is the chief of all manures; because a quantity of it may be collected in every farm, and because it makes the quickest return. A field sufficiently dunged, will produce good crops four or five years.

Dung of animals that chew the cud, being more thoroughly putrefied than that of others, is fit to be mixed with the soil without needing to be collected into a dunghill. A horse does not chew the cud; and in horse-dung may be perceived straw or ryegrass broken into small parts, but not dissolved: it is proper therefore that the putrefaction be completed in a dunghill. It ought to be mixed there with cool materials: so hot it is, that in a dunghill by itself, it singes and burns instead of putrefying. The difference between the dung of a horse and of a horned animal, is visible in a pasture-field: the grass round the former is withered; round the latter, it is ranker and more verdant than in the rest of the field. A mixture of dry and moist stuff, ought to be studied: the former attracting moisture from the latter, they become equally moist.

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To prevent sap from running out of a dunghill, its situation should be a little below the surface; and to prevent rain from running into it, it should be surrounded with a ring of sod. If the soil on which the dunghill stands be porous, let it be paved, to prevent the sap from sinking into the ground. If moisture happen to superabound, it may be led off by a small gutter to impregnate a quantity of rich mould laid down to receive it, which will make that mould equal to good dung.

Straw should be prepared for the dunghill, by being laid under cattle, and sufficiently moistned. When laid dry in a dunghill, it keeps it open, admits too much air, and prevents putrefaction.

Dung from the stable ought to be carefully spread on the dunghill, and mixed with the former dung. When left in heaps upon the dunghill, fermentation and putrefaction go on unequally.

Complete putrefaction is of importance with regard to the seed of weeds that are in the dunghill: if they remain sound, they are carried out with the dung, and infest the ground. Complete putrefaction is of still greater importance by pulverising the dung; in which condition it mixes intimately with the soil, and operates the most powerfully. In land intended for barley, undigested dung has an unhappy effect: it keeps the ground open, admits drought, and prevents the seed from springing. On the other hand, when thoroughly

thoroughly rotted, it mixes with the soil, and enables it to retain moisture. It follows, that the properest time for dunging a field, is in its highest pulveration; at which time the earth mixes intimately with the dung. Immediately before setting cabbage, sowing turnip, or wheat, is a good time. Dung divides and spreads the most accurately when moist. Its intimate mixture with the soil is of such importance, that hands should be employed to divide and spread any lumps that may be in it. Tho' dung is the chief manure in Scotland, the generality of our farmers seem not to give due attention to it. They are not only negligent in collecting materials, but apply it green without being putrified. It may be justly said that the half at least of its benefit is lost; or, in other words, that the effect would be double were it well prepared and mixed intimately with the soil.

Dung should be spread, and plowed into the ground, without delay. When a heap lies two or three weeks, some of the moisture sinks into the ground, which will produce tufts of corn more vigorous than in the rest of the field. There cannot be a worse practice than to lead out dung before winter, leaving it exposed to frost and snow. The whole spirit of the dung is extracted by rain, and carried off with it. The dung divested of its sap becomes dry in spring, and incapable of being mixed with the mould. It is

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turned

turned over whole by the plough, and buried in the furrow.

I approve not of plowing down buck-wheat, red clover, or any other crop, for manure. The best way of converting a crop into manure is, to pass it through the body of an animal. The dung and urine, not to mention the profit of feeding, will enrich the ground more than to plow down the crop.

As dung is an article of the utmost importance in husbandry, one should imagine, that the collecting it would be a capital article with an industrious farmer. Yet an ingenious writer, observing that the Jamaicans are in this particular much more industrious than the British, ascribes the difference to the difficulty of procuring dung in Jamaica. “ In England, where the long
“ winter enables a farmer to raise what quantity
“ he pleases, it is not collected with any de-
“ gree of industry. But in Jamaica, where
“ there is no winter, and where the heat of the
“ sun is a great obstruction, the farmer must be
“ indefatigable, or he will never raise any dung.” Cool interest is not alone a sufficient motive with the indolent, to be active. As dung is of great importance in husbandry, a farmer cannot be too assiduous, in collecting animal and vegetable substances that will rot. One article of that kind there is, to collect which there is a double motive, and yet is neglected almost every where.

A farm full of weeds is a nuisance to the neighbourhood: it poisons the fields around; and the possessor ought to be disgraced as a pest to society. Now the cutting down every weed before the seed is formed, answers two excellent purposes. First, it encourages good crops by keeping the ground clean. Next, these weeds mixed with other materials in a dunghill, will add considerably to the quantity of dung*.

In erecting a large dunghill, a cart and horses are commonly employed to lay the materials upon it; and in a dunghill of a smaller size, a hand barrow is commonly employed. This practice I cannot approve; for where a dunghill is much trodden upon, the air is excluded from the parts that are the most compressed, which prevents putrefaction. A dunghill composed, as it ought to be, of half digested materials, may be raised as high as can be done with the reach of the hand: its own weight will compress it sufficiently for putrefaction. And to prevent evaporation, it may be finished with a covering of fine earth and barley sown on it.

Next of lime, which is a profitable manure, and greatly profitable when it can be got in plenty within a moderate distance. Philosophers differ widely about its nature, and the cause of its

* At the roots of hedges in England fronting the high-road, the weeds grow in quantity sufficient, if collected, to make many thousand cart-loads of dung yearly.

its effects; and they talk so loosely, as to convince a plain farmer that the matter is very little understood. But practice is our present theme; and the benefit of lime is so visible, that the use of it has become general, where the price and carriage are moderate.

However people may differ in other particulars, all agree, that the operation of lime depends on its intimate mixture with the soil; and therefore that the proper time of applying it, is when it is perfectly powdered and the soil at the same time in the highest degree of pulveration. This opinion appears to have a solid foundation. Lime of itself is absolutely barren; and yet it enriches a barren soil. Neither of the two produces any good effect without the other: therefore the effect must depend on the mixture; and consequently the more intimately they are mixed the effect must be the greater*.

Hence it follows, that lime ought always to be slaked with a proper quantity of water, because by that means it is reduced the most effectually into powder. Lime left to be slaked by a moist air, or accidental rain, is seldom or never thoroughly reduced into powder; and therefore can never be intimately mixed with the soil. Sometimes

* Mr Buchanan of Achleshy, in Perthshire, prepared a quantity of lime for manuring a moor plowed before winter. Lime was immediately spread upon a part of it; but the work was stopped by bad weather. The remaining

times an opportunity offers to bring home shell-lime before the ground is ready for it; and it is commonly thrown into a heap without cover, trusting to rain for slaking. The proper way is, to lay the shell-lime in different heaps on the ground where it is to be spread, to reduce these heaps into powder by slaking with water, and to cover the slaked lime with sod so as to defend it from rain. One however would avoid as much as possible the bringing home lime before the ground is ready for it. Where allowed to lie long in a heap, there are two bad consequences: first, lime attracts moisture, even though well covered,

maining lime was indeed covered with sod, but so slightly as not to throw off the rain. When laid on the rest of the field in March, it was so clotted as to be but imperfectly mixed with the soil. The crop of oats on the part first limed was good; that on the part last limed was good for nothing. The subsequent crops however on this part proved tolerable, the lime, by repeated plowings being better mixed with the soil.—In several parts of Scotland are found limestone of two different sorts. The operation of the one is quick, when spread upon a field after calcination; but its prolific effects are soon over. The other operates more slowly; but its prolific effects continue longer. The former upon being slaked falls readily into a very fine powder; the latter falls more slowly into a powder that is not so fine. This accounts for the difference. The fine powder mixes more intimately with the soil, and more quickly, than the coarse powder. For the same reason, the fine powder makes the best cement, by mixing easily and perfectly with the sand and water.

vered, and runs into clots, which prevents an intimate mixture ; and, next, we learn from Dr Black, that burnt limestone, whether in shells or in powder, returns gradually into its original state of limestone ; and upon that account also, is less capable of being mixt with the soil. And this is verified by a fact, that after lying long, it is so hard bound together as to require a pick-axe for breaking it down. Therefore, make it an indispensable rule not to manure wet ground with lime : it will run into clots, and never mix intimately with the earth.

For the same reason, it is a bad practice, tho' common, to let spread lime lie on the surface all winter. The bad effects above-mentioned take place here in part : and there is another ; that rain washes the lime down to the furrows, and in a hanging field carries the whole away.

As the particles of powdered lime are both small and heavy, they quickly sink to the bottom of the furrow, if care be not taken to prevent it. In that view, it is a rule, that lime be spread and mixed with the soil, immediately before sowing, or along with the seed. In this manner of application, there being no occasion to move it till the ground be stirred for a new crop, it has time to incorporate with the soil, and does not readily separate from it. Thus, if turnip-seed is to be sowed broadcast, the lime ought to be laid on immediately before sowing, and harrowed in with the

the seed. If a crop of drilled turnip or cabbage be intended, the lime ought to be spread immediately before forming the drills. With respect to wheat, the lime ought to be spread immediately before seed-furrowing. If spread more early, before the ground is sufficiently broken, it sinks to the bottom. If a light soil be prepared for barley, the lime ought to be spread after seed-furrowing, and harrowed in with the seed. In a strong soil, it sinks not so readily to the bottom; and therefore, before sowing the barley, the lime ought to be mixed with the soil by a brake. Where moor is summer-fallowed for a crop of oats next year, the lime ought to be laid on immediately before the last plowing, and braked in as before. It has sufficient time to incorporate with the soil before the land is stirred again.

The quantity to be laid on, depends on the nature of the soil. Upon a strong soil, seventy or eighty bolls of shells are not more than sufficient, reckoning four small firlots to the boll, termed wheat-measure; nor will it be an overdose to lay on a hundred bolls. Between fifty and sixty may suffice upon medium soils; and upon the thin or gravelly, between thirty and forty. It is not safe to lay a much greater quantity on such soils.

It is common to lime a pasture-field immediately before plowing. This is an unsafe practice: it is thrown to the bottom of the furrow, from which

which it is never fully gathered up. The proper time for liming a pasture-field, intended to be taken up for corn, is a year at least, or two, before plowing. It is washed in by rain among the roots of the plants; and has time to incorporate with the soil.

With regard to the expence of carriage, to have the lime-kiln so near as to go twice a-day, is a great saving. But if there can be but one carriage in a day, there is little difference as to expence, whether the distance be seven or eleven miles. A little more food to the cattle makes all equal.

Limestone beat small makes an excellent manure, and supplies the want of powdered lime, where there is no fuel to burn the limestone. Limestone beat small has not hitherto been much used as a manure; and the proportion between it and powdered lime has not been ascertained. What follows may give some light. Three pounds of raw lime is by burning reduced to two pounds of shell-lime. Yet nothing is expelled by the fire but the air that was in the limestone: the calcarious earth remains entire. *Ergo*, two pounds of shell-lime contain as much calcarious earth as three pounds of raw limestone. Shell-lime of the best quality, when slaked with water, will measure out to thrice the quantity. But as limestone loses none of its bulk by being burnt into shells, it follows, that three bushels of raw
limestone

limestone contain as much calcarious earth as six bushels of powdered lime. And consequently, if powdered lime possess not some virtue above raw limestone, three bushels of the latter beat small should equal as a manure six bushels of the former.

Shell-marl, as a manure, is managed in every respect like powdered lime, with this only difference, that a fifth or a fourth part more in measure ought to be given. The reason is, that shell-marl is less weighty than lime, and that a boll of it contains less calcarious earth, which is the fructifying part of both.

I shall conclude with clay and stone marls, which, with respect to husbandry, are the same, though in appearance different. The manures hitherto mentioned are restoratives only: they recruit land when worn out by cropping, and enable it to bear more crops. The marl now under consideration is not only a restorative, but has an effect still more desirable, that of altering the nature of the soil, and improving its texture, so as to convert it from light to heavy, and from weak to strong. I know nothing comparable to it in that respect, but the poaching light land by cattle fed with turnip, mentioned in a foregoing chapter. It has another effect, in appearance opposite; which is, to loosen a clay soil, and to make it more free.

The goodness of this marl depends on the

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quantity

quantity of calcarious earth in it ; which I have known to amount to a half or more. It is too expensive if the quantity be less than a third or a fourth part. Good marl is the most substantial of all manures ; because it improves the weakest ground to equal the best borough-acres. One instance I know, of two ridges marked a hundred and twenty years ago, that at this day make a figure both in grass and corn far above the rest of the field. The low part of Berwickshire, termed *the Merse*, abounds every where with this marl ; and in no other part of Scotland is it in such plenty.

As none of the manures I am acquainted with make any distinction between weeds and corn, the land ought to be cleared of weeds before marling ; and it ought to be smoothed with the brake and harrow, in order that the marl may be equally spread. Marl is a fossil on which no vegetable will grow : its efficacy depends, like that of lime, on its pulveration, and intimate mixture with the soil. Toward the former, alternate drought and moisture contribute greatly, as also frost. Therefore after being evenly spread, it ought to lie on the surface all winter. In the month of October, it may be roused with a brake, which will bring to the surface, and expose to air and frost, all the hard parts, and mix with the soil all that is powdered. In that respect it differs widely from dung and lime, which ought

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to be plowed into the ground without delay. Oats is a hardy grain, which answer for being the first crop after marling, better than any other; and it will succeed though the marl be not thoroughly mixed with the soil. In that case, the marl ought to be plowed in with an ebb furrow immediately before sowing, and braked thoroughly. It is ticklish to make wheat the first crop: if sown before winter, frost swells the marl, and is apt to throw the seed out of the ground; if sown in spring, it will suffer more than oats by want of due mixture.

Summer is the proper season for marling; because in that season the marl, being dry, is not only lighter, but is easily reduced to powder. Frost however is not improper for marling, especially as in frost there is little opportunity for any other work.

Marl is a heavy body, and sinks to the bottom of the furrow, if indiscreetly plowed. Therefore the first crop should always have an ebb furrow. During the growing of that crop, the marl has time to incorporate with the soil, and to become a part of it; after which it does not readily separate.

Stone marl is so hard by a considerable mixture of sand, that it will continue without dissolving for years. In that case, the expence of breaking the larger lumps with hammers would not be lost: such lumps have no effect to promote vegetation;

getation ; and they are beside an obstruction to plowing and harrowing.

About twenty years ago, many Merse tenants applied their whole strength to marling, with very great success: and yet of late they seem more intent on liming ; which may appear singular in a country where husbandry goes on with alacrity. But leases in that country are commonly limited to nineteen years, which, it is thought, affords too little time for drawing all the profit from this expensive manure, that the tenant is intitled to. To marl to perfection, requires four hundred cart-load on an acre, as much as can be drawn by two sturdy horses ; which, at a moderate computation, costs about L. 4 *per* acre. But a field can be sufficiently limed from the distance of fifteen English miles, for little above the half of that sum ; with this additional convenience, that a farmer can hire carts for liming, instead of being confined to his own horses, as he must be in marling ; by which means, liming can be carried on with much more expedition than marling. Notwithstanding these differences, it is easy to evince, that even on a lease of nineteen years, marl will afford a greater profit than lime. Limed ground cannot bear without injury above three or four crops ; after which it ought to be laid down in grass. A field well marled, will produce rich crops of corn, in the simplest manner of culture, as long as the lease endures. Now, though

though grass is more profitable than corn in a poor soil, the profit bears no proportion in a rich soil, which produces excellent crops, with no greater labour nor expence than is necessarily bestowed on poor soil.

C H A P. XII.

FENCES.

IN Scotland, fences of several kinds are used. Stone-walls and thorn-hedges are the best and the most common.

The height of a dry-stone wall is directed by the use it is intended for. If intended for sheep, it cannot be under six feet high, every rood of which, being thirty-six square ells, will at a medium cost twenty shillings. A dry-stone wall for horses or horned cattle cannot be under five feet high. The expence of inclosing in this manner is considerable. A square field of ten acres inclosed with a wall six feet high, will cost L. 50, 15s.; and L. 42 : 5 : 10, if the wall be five feet high. And it will require two and one half *per cent.* annually to keep them in order. To build with lime, as many do, inflames the cost; and yet upon the whole is a saving where lime is at hand.

To reduce both the expence of building dry-stone walls, and of upholding them, I warmly recommend

commend the following mode. Raise the wall to the height only of two feet and a half, and cope it with fod in the following manner. First, lay on the wall with the grassy side under, fod cut with the spade four or five inches deep, and of a length to equal the thickness of the wall. Next, cover this fod with loose earth rounded like a ridge. Third, prepare thin fod, cast with the paring spade, so long as to extend beyond the thickness of the wall two inches on each side. With these cover the loose earth, keeping the grassy side above: place them so much on edge as that each fod shall cover part of another, leaving only two inches without cover. Fourth, when twenty or thirty yards are thus finished, let the fod be beat with mells by two men, one on each side of the wall, striking both at the same time. By this operation, the fod becomes a compact body that keeps in the moisture, and encourages the grass to grow. Lastly, cut off the ragged ends of the fod on each side of the wall, to make the covering neat and regular. The month of October is the proper season for this operation, because the sun and wind, during summer, dry the fod and hinder the grass from vegetating. Moist soil affords the best fod. Wet soil is commonly too fat for binding; and at any rate, the watery plants it produces will not thrive in a dry situation. Dry soil, on the other hand, being commonly ill bound with roots, shakes to pieces

pieces in handling. The ordinary way of coping with sod, which is to lay them flat and single, looks as if intended to dry the sod and to kill the grass; not to mention, that the sod is liable to be blown off the wall by every high wind.

Having finished the wall, make a ditch on each side, beginning a foot from the root of the wall, and sloping outward to the depth of three feet, or at least two and a half. The ditch should be equally sloped on the other side, so as to be four feet wide.

A rood of this fence, including every article, may be done for three shillings or thereabout; and a field of ten acres may be thus inclosed for about L. 30. If the ditch be made three feet deep, the fence will be above six feet high; and above L. 20 will be saved of what a dry-stone wall six feet high will cost. Nor is the saving of this sum the most considerable article. A fence of which the parts are so well connected, will stand many years with little or no reparation. That this is far from being the case of a dry-stone wall six feet or even five feet high, all the world know. Though a deer-park of great extent, such as we see many in England, is no favourite of mine, I have no objection to one of forty or fifty acres; which may be inclosed at a very small expence. After surrounding it with the wall here described, plant within laburnums close to the wall. Lope off their heads to make the branches

branches extend laterally and interweave in form of a hedge. The wall will prevent the deer from breaking through; and if the hedge be trained eight feet high, they will not attempt to leap over. I prefer the laburnum, because no beast will feed on it, except a hare, and that only when young and the bush tender. Therefore no extraordinary care is necessary, except to preserve them from the hare four or five years. A row of alders may be planted in front of the laburnums, which a hare will not touch nor any other beast.

Next of thorn-hedges. The advantage of the white thorn for a fence above every other plant, is well understood. It is a quick grower when planted in proper soil, shooting up six or seven feet in a season. Though tender when young and hurt by weeds, it turns strong, and may be cut into any shape. Even when old, it is more disposed than other trees to lateral shoots. And, lastly, its prickles make it the most proper of all for a fence.

The method of sowing the seed in beds, is set forth in the chapter of Forest-Trees. After the plants have stood a full year in the seed-bed, transplant the largest into a nursery, which will leave sufficient room for the remainder, to stand where they are another year. In the nursery, they ought to stand at the distance of seven, eight, or nine inches from each other; and there they may remain till fit to be planted in a hedge, which is no sooner than at the age of five. Room in a nursery

nursery is of great importance : when straitened for room, the plants shoot up fast, are weakly, and unfit to bear the hardships of an open field. The distance ought to be proportioned to the soil ; the greatest in a rich soil, because they grow fast ; the least in a poor soil, where they grow slow. The best soil for a nursery is between rich and poor. In the latter, the plants are dwarfish : in the former, being luxuriant and tender, they are apt to be hurt during the severity of weather : and these imperfections are incapable of any remedy. An essential requisite in a nursery is free ventilation. How common is it to find nurseries in hollow-sheltered places, surrounded with walls and high plantations, more fit for pine-apples than for barren trees ! The plants thrust out long shoots, but feeble and tender : when exposed to a cold situation, they decay, and sometimes die. But there is a reason for every thing : the nurseryman's view is to make profit by saving ground, and by imposing on the purchaser tall plants, for which he pretends to demand double price. It is so difficult to purchase wholesome and well-nursed plants, that every gentleman-farmer ought to raise plants for himself.

As thorns will grow pleasantly from roots, I have long practised a frugal and expeditious method, of raising them from the wounded roots that must be cut off when thorns are to be set in a hedge. These roots cut into small parts, and

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put in a bed of fresh earth, will produce plants the next spring, no less vigorous than what are produced from seed. And thus a perpetual succession of plants may be obtained without any more seed.

It ought to be a rule, never to admit into a hedge plants under five years old : they deserve all the additional sum that can be demanded for them. Young and feeble plants in a hedge, are of slow growth ; and beside loss of time, the paling, necessary to secure them from cattle, must be renewed more than once before they become a fence.

A thorn-hedge may be planted in every month of winter and spring, unless it be frost. But I have always observed, that thorns planted in October are more healthy, push more vigorously, and fewer decay, than at any other time. In preparing the thorns for planting, the roots ought to be left as entire as possible, and nothing cut away but the ragged parts.

As a thorn-hedge suffers greatly by weeds, the ground where they are to be planted ought to be made perfectly clean. The common method of planting is, to leave eight or nine inches along a side of the intended ditch, termed a scarfement ; and behind the scarfement to lay the surface-soil of the intended ditch, cut into square fods two or three inches deep, its grassy surface under. Upon that fod, whether clean or dirty,
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the thorns are laid, and the earth of the ditch above them. The grass in the scarfement, with what weeds are in the moved earth, soon grow up, and require double diligence to prevent the young thorns from being choked. The following method, which is creeping into practice, deserves all the additional trouble it requires. Leaving a scarfement as above of ten inches, and also a border for the thorns, broad or narrow according to their size, lay behind the border all the surface of the intended ditch, champed small with the spade, and upon it lay the mouldery earth that fell from the spade in cutting the said surface. Cover the scarfement and border with the under earth, three inches thick as least; laying a little more on the border to raise it higher than the scarfement, in order to give room for weeding. After the thorns are prepared, by smoothing their ragged roots with a knife, and lopping off their heads in order to make them grow bushy, they are laid fronting the ditch, with their roots on the border, the head a little higher than the root. Special care must be taken to spread the roots among the surface-earth taken out of the ditch, and to cover them with the mouldery earth that lay immediately below. This article is of importance, because the mouldery earth is the finest of all. Cover the stems of the thorns with the next *stratum* of the ditch, leaving always an inch at the top free. It is no matter how

how poor this *stratum* be, as the plants draw no nourishment from it. Go on to finish the ditch, pressing down carefully every row of earth thrown up behind the hedge, which makes a solid mound impervious to rain. It is a safeguard to the young hedge to raise this mound as perpendicular as possible; and for that end it may be proper in loose soil, when the mound is raised a foot or so, to bind it with a row of the tough sod, which will support the earth above, till it become solid by lying.

This is sufficient in rich soil; but in poor soil greater care is necessary. Behind the line of the ditch, the ground intended for the scarfement and border should be summer-fallowed, manured, and cleared of all grass-roots; and this culture will make up for the inferiority of soil. In very poor soil it is vain to think of planting a thorn-hedge; for it will give no satisfaction, because it never will become a fence. In such ground there is a necessity for a stone fence.

The only reason that can be given for laying thorns as above described, is to give the roots space to push in all directions, even upward into the mound of earth. There may be some advantage in this; but, in my apprehension, the disadvantage is much greater of heaping so much earth on the roots, as to exclude not only the sun and air, but even rain which runs down the sloping bank, and has no access to the roots. In-
stead

stead of laying the thorns fronting the ditch, would it not do better to lay them parallel to the ditch; covering the roots with three or four inches of the best earth, which would make a hollow between the plants and the sloping bank? This hollow would intercept every drop of rain that falls on the bank, to sink gradually among the roots. If this be not a better position for a thorn, it must be of a singular constitution. I venture one step farther out of the common path. Why at any rate should a thorn be put in the ground sloping? This is not the practice with respect to any other tree; and I have heard of no experiment to persuade me that a thorn thrives better sloping than erect. But as in natural history experiment is always our last resource, I am at present following out a comparative trial. I have many young hedges in the way first described: some I have laid parallel to the ditch in the way now described, and some I have planted erect with their tops entire. The trials are fairly made; and time will determine the best method. There indeed occurs one objection against planting the thorns erect, that the roots have no room to extend themselves on that side where the ditch is. But does it not hold that when in their progress roots meet a ditch, they do not push onward, but changing their direction push downward at the side of the ditch? (See appendix article 4th.) If so, these downward roots will support

port the ditch, and prevent it from being mouldered down by frost.

One thing is evident without experiment, that thorns planted erect may sooner be made a complete fence than when laid sloping as usual. In the latter case, the operator is confined to thorns that do not exceed a foot or 15 inches; but thorns five or six feet high may be planted erect and a hedge of such thorns, well cultivated in the nursery, will in three years arrive to greater perfection, than a hedge managed in the ordinary way will do in twice that time.

In a rich soil the thorns may be planted ten inches asunder; and from that to six inches in inferior soils. To preserve them from cattle, the ditch ought to be six feet wide, three feet deep, and as narrow at bottom as the breadth of the spade will allow. But when the thorns are sufficiently covered, the prudent way is to delay finishing the ditch till the frost be over. Spring is the proper time for completing the work, while there is sufficient sap in the soil to bind the mound of earth that is raised behind the thorns. If delayed till the earth be dry, it never binds: if completed the beginning of winter, frost swells the earth, loosens it, and makes it crumble down.

The hedge is fenced from cattle on the one side by the ditch; but it is necessary that it be fenced on both sides. The ordinary method of a paling is no sufficient fence against cattle: the most gentle

gentle make it a rubbing-post; and the vicious break it down wantonly with their horns. The only effectual remedy is expensive; but better no fence than one that is imperfect. The remedy is, two ditches and two hedges, with a high mound of earth between them. Survey Scotland, and you will not find any fences otherwise constructed without many breaches; the repairing of which gives much trouble and little satisfaction. If this remedy however be not palatable, the paling ought at least to be of the strongest kind. Many different kinds have been put in practice, that are extremely frail. I recommend the following, as the best I am acquainted with. Drive into the ground strong stakes three feet and a half long, with intervals from eight to twelve inches, according to the size of the cattle that are to be enclosed; and all precisely of the same height. Prepare plates of wood sawed out of logs, every plate three inches broad and half an inch thick. Fix them on the head of the stakes, with a nail driven down into each stake. The stakes will be united so firmly, that one cannot be moved without the whole; and will be proof accordingly against the rubbing of cattle. But, after all, it is no fence against vicious cattle. The only proper place for it is the side of a high-road, or to fence a plantation of trees. It will indeed be a sufficient fence against sheep, and endure till the hedge itself be a fence. A fence thus completed,

ed, including thorns, ditching, wood, nails, &c. will not much exceed two shillings every six yards.

We are now arrived at the most important article of all, that of training up a thorn-hedge after it is planted. The ordinary method is, to cut off the top and shorten the lateral branches, in order to make it thick and bushy. To the same end, the young thorns, after standing six or seven years, are sometimes cut over within two or three inches of the ground, which multiplies the stems, and makes the hedge still thicker. This form of a hedge catches the eye: by its thickness it is formidable to cattle; but its weakness is discovered when bare of leaves, and cattle break through every where without obstruction.

I have the experience of three hedges trained twelve years as follows. The first has been annually pruned top and sides. The sides of the second have been pruned, but the top left entire. The third was allowed to grow without any pruning. The first is at present about four feet broad and thick from top to bottom; but weak in its stems, and unable to resist any horned beast. The second is strong in its stems, and close from top to bottom. The third is also strong in its stems, but for two feet up bare of lateral branches, which have been destroyed by the overshadowing of those above, depriving them both of rain and
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air. That the second is the best method, is ascertained by experience. And that it ought to be so, will be evident if we can trust to analogy: in the natural growth of a tree, its trunk is proportioned to its height: lop off the head, it spreads laterally and becomes a bush, without rising in height, or swelling in the trunk. The lime-tree is the only exception I know: the white thorn I am certain is not an exception. Hence the following method of training up a hedge, which is to allow the thorns to grow without applying a knife to their tops, till their stems be five or six inches in circumference. In good soil with careful weeding, they will be of that bulk in ten or twelve years, and be fifteen feet high or upward. The lateral branches only must be attended to. Those next the ground must be pruned within two feet of the stem: those above must be made shorter and shorter, in proportion to their distance from the ground; and at five feet high they must be cut close to the stem, leaving all above full freedom of growth. By this dressing, the hedge takes on the appearance of a very steep roof; and it ought to be kept in that form by pruning. This form gives free access to rain, sun, and air: every twig has its share, and the whole is preserved in vigour. When the stems have arrived at their proper bulk, cut them over at five feet from the ground, where the lateral branches end. This answers two excellent pur-

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poses. The first is, to strengthen the hedge, the sap that formerly ascended to the top being now distributed among the branches. The next is, that a tall hedge stagnates the air, and poisons both corn and grass near it. A hedge trained up in this manner, is impenetrable even by a bull: he may press in the lateral branches; but the stems stand firm. For an instant proof that this method will answer, observe the thorns that from space to space are allowed to grow up above their fellows in form of a hedge-row. These thorns, though growing in the middle of a bushy hedge, have stems far larger than the rest. Beside the strength of such a hedge, it is less expensive than a hedge reared in the ordinary way: the weeds are sooner choaked; and it requires much less pruning. If the ground have been prepared for the plants by cleaning it perfectly, the hedge may be safely left to itself for four or five years; unless it be to shorten any luxuriant branch that grows much faster than the rest. When so much labour is saved, one will the less grudge the price of the best thorns that can be procured. Good thorns are indeed more essential in this manner of training a hedge than in any other: they ought all to be of an equal size, and equally vigorous, that they may not overtop one another. The intermixing of strong and weak plants is of less importance, where the heads are cut off and all made to grow equally.

Plashing

Plashing an old hedge, an ordinary practice in England, makes indeed a good interim fence ; but at the long-run is destructive to the plants : and accordingly, there is scarce to be met with a complete good hedge where plashing has been long practised. A cat is said among the vulgar to have nine lives : is it their opinion, that a thorn, like a cat, may be cut and slashed at will without suffering by it ? A thorn is a tree of long life. If instead of being massacred by plashing, it were raised and dressed in the way here described, it would continue a firm hedge perhaps five hundred years. This merits attention.

A hedge ought never to be planted on the top of the mound of earth thrown up from the ditch. It has indeed the advantage of an awful situation ; but being planted in bad soil, and destitute of moisture, it cannot thrive : it is at best dwarfish, and frequently decays and dies.

To plant trees in the line of the hedge, or within a few feet of it, ought to be absolutely prohibited, as a pernicious practice. It is amazing, that people should fall into this error, when they ought to know, that there never was a good thorn-hedge with trees in it. And how should it be otherwise ? an oak, a beech, an elm, grows faster than a thorn : when suffered to grow in the midst of a thorn-hedge, it spreads its roots every where, and robs the thorns of their nourishment. Nor is this all : the tree overshadowing the
thorns

thorns keeps the sun and air from them. At the same time, no tree takes worse with being overshadowed than a thorn *.

It is scarce necessary to mention gaps in a hedge ; because they will seldom happen where a hedge is trained as above recommended. But in the ordinary method of training, gaps are frequent, partly by the failure of plants, and partly by the trespassing of cattle. The ordinary method of making up gaps is, to plant sweet brier where the gap is small, and a crab where it is large. This method I cannot approve, for an obvious reason : a hedge ought never to be composed of plants that grow unequally : those that grow fast overtop and hurt the slow growers ; and with respect in particular to a crab and sweet brier, neither of them thrive under shade. It is a better method to remove all the withered earth in the gap, and to substitute fresh sappy mould mixed with some lime or dung. Plant upon it a vigorous thorn of equal height with the hedge, which in its growth will equal the thorns it is mixed with. In that view, there should be a nursery

* In England there is scarce a thorn-fence to be seen without a hedge-row of trees ; and these hedge-rows have been the destruction of fences. The thorns, as far as the roots or branches of the trees extend, must decay. It is in vain to put young thorns in the gap, for they will not take root. To fill up gaps, plashing became necessary. Plashing for a time makes a strong fence ; and by that means became general.

nursery of thorns of all sizes, even to five feet high, ready to fill up gaps. The best season for this operation is the month of October. I should have added, that a gap filled with sweet brier, or a crab lower than the hedge, invites cattle to break through and trample the young plants under foot; to prevent which a paling on both sides is not sufficient, unless it be raised as high as the hedge*.

With respect to a field that is too poor for thorns, what shall be the fence if there be no stones in the neighbourhood? In such fields, a hedge of whins is the only resource. Whin-hedges stand commonly on the top of a dry earth-dyke, in which situation they seldom thrive well. I like what follows better. Two parallel ditches three feet wide and two deep, border a space of twelve feet. Within this space, raise a bank at the side of each ditch with the earth that comes out of it, leaving an interval between the two banks. Sow the banks with whin seed, and plant a row of trees in the interval. When the whins are pretty well grown, the hedge on one of the banks may be cut down; then the other
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* In several parts of England, a vicious practice has crept in of cutting off the lowest lateral branches, leaving a bushy top, but the stem bare. This I presume must be in imitation of a tree, for it cannot otherwise be accounted for; and yet the general practice is to avoid the form of a tree as much as possible.

as soon as the first becomes a fence; and so on alternately. While the whins are young, they will not be disturbed by the cattle, if passages be left to go out and in. These passages may be closed up, when the hedge is sufficiently strong to be a fence. A whin-hedge thus managed, will last many years, even in strong frost unless very severe. There are many whin hedges in the shire of Kincardine, not so skilfully managed; and yet the possessors appear not to be afraid of frost. Such fences ought to be made extremely welcome in the sandy grounds of the shire of Murray, where there is scarce a stone to be found. The few earth fences that are there raised, composed mostly of sand, very soon crumble down.

Nothing hitherto has been said about an enclosure for sheep. To carry a farm to its perfection, every enclosure ought to be made so as to keep in sheep, though not chiefly intended for them; for sheep ought to be mixed with other cattle in every pasture-field: they eat what others leave, and others eat what they leave. But farmers generally take a humbler flight, and are satisfied with one or two enclosures for sheep. In that view I premise, that of all animals sheep naturally take the widest range in feeding; for which reason, an enclosure for them ought never to be under fifty or sixty acres. Where they have so much room, any fence will keep them in: where confined

confined to five, six, or even ten acres, the most awful fence is scarce sufficient. I talk of the common run of sheep; not of the large Lincolnshire breed, habituated to enclosures, which have no genius for leaping.

Where stones are to be had, the cheapest and most effectual is the stone fence above described. If a farm cannot afford an enclosure so large as that now mentioned, the deepness of the ditch ought to be in a reciprocal proportion to the size of the enclosure: in a small enclosure, the fence ought at least to be six feet high. If the farmer be reduced to a quickset hedge by want of stones, the scarfement must be eighteen inches broad, in order to receive a paling between the root of the hedge and lip of the ditch; inclining to the ditch in form of a stocade, which will make it the more awful. This will fit the enclosure immediately for sheep, without waiting the slow growth of the hedge. When the paling fails, the ditch must be lined up with stones to the height of the hedge, to prevent the sheep from making a road up the side of the ditch to come at the thorns; which would ruin all; for no food is so palatable to them as the leaves of thorn. Where stones are scarce, two feet of stones may do, raising the lining to the height of the thorns with sod.

One thing is never to be omitted in a large enclosure. Sheep require a shelter against heat, no less than against cold. The stone fence recommended,

mended, affords little shelter against either. Therefore, a shelter ought to be made somewhere in the driest part of the field. Plant ten or twelve rows of Scotch fir or spruce fir in a curve, semicircular, or elliptical, the concave fronting the south, and sufficiently capacious for beds to all the sheep. Surround this plantation with a stone fence of the same form with what encloses the field. The weakest trees ought to be weeded out from time to time, which will give the trees that stand room to extend their lateral branches. And the plantation when grown up will protect the sheep both from sun and wind. The dung dropt round this sheltered place, may be gathered and put in a dunghill, or spread upon the field.

A sheep yields more profit by pasture than any other animal; and as its dung enriches the soil more, I must repeat again, that a provident farmer ought to have more enclosures than one: he will have the benefit of fine crops of corn by removing successively sheep from one enclosure to another.

With respect to the size of enclosures, several considerations enter. Sheep naturally take a compass in feeding: if restrained by a small enclosure, it will require a strong fence to keep them in: if they have scope in an enclosure of 30 or 40 acres, they never think of going out. An enclosure of 20 or 25 acres is sufficient for
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horses or for horned cattle. Enclosures of a large size have the advantage of free ventilation, essential while they are in corn. There are also other considerations to be kept in view in determining the size of an enclosure. One is, that the ditches ought to be so directed as to carry off superfluous moisture. Another, that different soils in the same enclosure ought to be avoided. As heat and shelter only seem to have been formerly thought of in the English enclosures, they are generally too small; by which that country has suffered greatly, labour lost, land lost, corn and grass lost within ten yards of the fence; and in a ticklish season, perhaps the whole lost for want of ventilation. The oppression of flies and stagnation of air, make summer pasture incommodious in a small enclosure. It indeed gives much shelter in winter; but that benefit is confined to a light soil, for loam or clay is apt to be poached by winter-pasture.

A word more before I end, which will be on the gates of enclosures. The post upon which the gate is hung, though built of stone and lime, is apt to be shaken by a heavy gate, and to be torn to pieces by a careless driver running the axle of his cart against it. But instead of building a wall in the line of the enclosure, let it be built perpendicular to it, seven or eight feet long, thickest in the middle and tapering toward the ends.

ends. Such a wall or post will be proof against any force.

C H A P. XIII.

THE PROPER SIZE OF A FARM, AND THE USEFUL ACCOMMODATIONS IT OUGHT TO HAVE.

TO confine a tenant to that quantity of land which can be managed to the best purpose with the least expence, is the surest means of obtaining an adequate rent without oppression. A farm ought never to contain a less quantity of land than sufficient for a plough ; and there is no medium between that quantity, and as much as will give full employment to two. Less than sufficient for a plough, is an evident loss to the tenant, and consequently to the landlord : the servants and cattle must at times be idle for want of work ; or, what is worse, they will work indolently, and make no progress. I have a striking proof of this observation. The estate of Grange in the parish of Falkirk, containing about 360 Scotch acres, paid of rent L. 450. It was possessed by no fewer than eleven tenants ; not one of the farms sufficient for a plough, several of them between twenty and thirty acres. A map was made : it was clearly seen, that the estate could hold but six tenants ; and it luckily happened, that there were

were six houses abundantly central for these tenants, without necessity of new buildings. The saving of twenty horses and ten servants, and the maintenance of five tenants and their families, was great ; beside the profit that each tenant was intitled to for his skill and labour. The six tenants that took the whole offered at once an advance of L. 194 Sterling, which was accepted, though not equal to the saving. And accordingly the present rent of L. 644 will be easier on the six tenants, than the former rent of L. 450 was on the eleven. A farm, on the other hand, that cannot be commanded by one plough, and is not sufficient for two, is a still greater loss. The tenant, struggling to make something of every field, does justice to no field ; and the farm turns poorer and poorer every year. It is well known, that most farms in Scotland are too large for the ability of the tenant. The reason is, that in an uncultivated country, the adding twenty or thirty acres more is little regarded. I could give many instances of a tenant beginning to thrive after being deprived of part of his farm. But it is unnecessary to give instances, for they are known every where.

When one thinks of calculating what quantity of land is sufficient for a single plough, many circumstances occur, that make it impracticable to determine the point with precision. The difference between a light and a heavy soil, is considerable ;

siderable ; and no less so, the nearness or distance of manure. The mode of cropping is capital : where all the different plants are sown in spring and reaped in autumn, more ploughs are requisite than when crops are dispersed through the year, according to the present improved mode of culture. I venture only in general to say, that in most soils fifty acres of corn may be commanded by a single plough, provided the crops be distributed through the year, to afford time for managing all of them with the same men and cattle. But where grass is necessary for keeping the soil in heart, a farm ought to be enlarged in proportion to the quantity of grass required ; for there ought always to be as much land in tillage as fully to occupy a plough. If a third part in grass be sufficient, the farm ought to consist of seventy-five acres ; if a half be necessary, the farm ought to be 100 acres ; and if the soil be so mean as to require two-thirds in grass, the extent of the farm ought to be 150 acres. If the reader be curious about further particulars, I refer him to the seventh chapter, in which a few examples are given of the number of acres that in different modes of cropping may be commanded by one plough. These examples will pave the way to computations corresponding to other rotations.

I proceed to an interesting article, which is to compare great and small farms in point of utility.

I call a small farm what employs but a single plough ; and a smaller there ought not to be. A middling farm is what requires two ploughs ; and whatever requires a greater number, I call a great farm. These different farms I shall consider with respect to the landlord, with respect to the tenant, and with respect to the public.

With respect to the landlord, there are advantages and disadvantages that tend to balance each other. Small farms draw the greatest number of candidates ; and consequently to produce the highest rents. On the other hand, small farms occasion a great expence for houses ; and in a country where building materials are costly, large farms may appear to be the interest of the landlord.

With respect to tenants, a farm as large as can accurately be managed, is undoubtedly the interest of a tenant, provided he have a fund for stocking the farm sufficiently. But this is really saying no more, but that it is beneficial to have a large fund. The proper question is, Whether with respect to farmers in general, it is not a convenience to have the choice of small or great farms according to their stock ? In that view, small farms are undoubtedly advantageous to those who want to be farmers ; because in Scotland, at least, the number is much greater of those who can stock a small farm, than of those who can go farther. It may be possibly objected, that
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there is an inconvenience in a small farm where two horses only are necessary for a plough, in respect that two horses make but a slow progress in carrying corn or dung. To this objection there is a ready answer: two horses in two single carts will make as much expedition in carrying out the dung, or carrying in the corn of a small farm, as double that number will make in a middling farm, where the dung and corn are double in quantity. I say further, that if two horses be not sufficient, the defect may be readily supplied by two draught oxen, which add very little to the expence of the farm. These at four years of age may be purchased for L. 10. They will give at seven L. 15; and this profit, with no more work than sufficient to give them a stomach, will balance their summer-food of green clover. Their winter food of straw cannot enter into the computation, being the very best way of converting straw into dung. Here there is a great convenience. Where a field, by drought or otherwise, is rendered too stiff for a pair, the oxen may be yoked in the plough with the horses. In ground less stiff, the farmer has a choice of two oxen and a horse, of two horses alone, or of two oxen. Where plowing happens to be retarded by bad weather, two ploughs may be employed, which is a signal convenience. Plowing also and harrowing may go on at the same time; and the farmer has it always in his power

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to yoke two double carts. Even in carse-soil this plan will answer ; as there is seldom occasion to employ the oxen but where the ground is sufficiently dry for them.

With respect to the public, small farms are undoubtedly the most advantageous. The number of servants, it is true, must be in proportion to the size of the farm : but in a middling farm there is but one tenant ; whereas in two small farms of no greater extent, there are two. And the difference is still greater in large farms. This is a capital circumstance. The children of tenants are taught to read and write ; and in general are better educated than children of day-labourers, which qualifies them better for being artists and manufacturers. They are also commonly more numerous, being better nourished during nonage, and better preserved from diseases. Small farms accordingly are not only favourable to population, but to the most useful population. I would not therefore indulge willingly any farm beyond a middle size. And to check those of a larger size, I am clear for a tax of L. 3. or L. 4 yearly upon every farm that requires three ploughs ; and so on according to the number. I except proprietors, who ought to be encouraged to improve their estates : let them employ as many ploughs as they find convenient, and not be subjected to any tax. If any undertaker be willing to lay out a large sum of money upon farming, the profit
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of a long lease will enable him to pay the tax. This tax at the same time may be so contrived, as to answer a valuable purpose, that of exciting farmers to use oxen instead of horses; which will be done by exempting oxen-ploughs from the tax. And the undertaker mentioned will be relieved from the tax altogether, if he employ such ploughs only.

THE size of a farm being adjusted, next in order are its accommodations. The first accommodation I shall mention is, an acre planted with trees proper for the farm; fir in particular and ash. The worst soil will answer the former, and moist soil the latter. These are at hand for paling and other purposes; and without such a convenience a tenant's hands are in a measure bound up.

Another accommodation follows. However well adjusted the size of a farm may be to the strength employed upon it; yet to have a farm in perfection there ought always to be some by-work, about which the servants and horses may be employed when the ordinary culture of the farm does not require them. There is a great difference between good and bad weather, with respect to expedition. The farmer must provide against the latter, by sufficiency of men and horses, which in the former have not full employment. Therefore, to provide against want of work,

work, there ought to be a resource, such as may be taken up or laid down as occasion offers. The carrying lime to a farm, or marl, or dung from a neighbouring town, are excellent resources.

The chief accommodation of all is, a fruitful kitchen-garden. Formerly, oat-meal was the only food of our labouring people; and when at five or six shillings *per* boll, there could not be cheaper food. A kitchen-garden was at that time a sort of luxury, and our simple peasants had no notion of luxury. By a great advance in the price of oats and oat-meal, a kitchen-garden has become an article of oeconomy; and yet scarce more attended to than formerly. Well dressed and cropped, it will afford half maintenance to a family; and yet this food would not cost much above the third of the price of oat-meal. But the ignorant are slaves to custom; and no value is put on a kitchen-garden at present, because it was of no value thirty years ago.

The extent of this garden depends on the manner of cropping the farm. Where red clover is one of the crops in the rotation, a kitchen-garden need not exceed two or three acres. Where red clover enters not into the rotation, six acres are the smallest quantity even for a single plough; because it must yield food both for man and beast. Take the following rotation, which at the same time is capable of greater variety in a kitchen-garden of greater extent than six acres. Two

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acres

acres are necessary for summer-food to the farm-cattle, cows, &c. Two acres more will be usefully employed in cabbage, colewort, turnip, carrot, potatoes, leeks, onions, turkey-beans, white pease and other kitchen-stuff, for food to the family. The remaining two acres must be sown with barley and red clover. To give directions for the culture of the vegetables intended for the family-use, would be a treatise on the kitchen-garden. I shall only slightly observe, that the early cabbage, termed *May cabbage*, may be set the end of February, or as soon after as the season answers; and will be ready for eating in May and June. Scotch cabbage ought to be set in March; and a few set in June will be ready for eating next spring. The season for sowing carrots, onions, and leeks, is the same with that of oats. Onions require a rich soil; and if that be wanting, leeks may supply their place. Potatoes ought never to be neglected: they make a hearty food, and the cheapest of all: upon which account, as many ought to be raised as will serve the family the year round. Turnip is proper for cows after calving; and to turnip may be added what cabbage or colewort are saved from the family-use. This succulent food will produce plenty of milk for rearing calves, an article little regarded in Scotland. Careful culture may afford some residue for feeding an old cow or ox during winter; which in spring may be sold to great advantage,

tage, instead of being fold the beginning of winter for a trifle.

A kitchen-garden is always surrounded with trees, from the notion that it requires shelter. Young plants require shelter ; but not those that are advanced in growth. Plants long sheltered in a kitchen-garden, are too tender for the field. And for evidence that they prosper greatly by a free circulation of air, they rise in the field to a much greater size than in a sheltered garden. When the trees that surround our kitchen-gardens are grown up, they fill the ground with their roots, and overshadow the plants with their branches. The plants are dwarfish even with all the dung that can be scraped together ; and yet the vegetable soil becomes deeper and deeper every year. I venture to pronounce, that it would be a considerable improvement in husbandry, to abandon all our kitchen-gardens, to chuse proper spots for them well ventilated, and to make manure of the soil of the old ones. Several thousand acres of poor land may by that means be improved. I have found great profit by that manure. I need scarce add, that the kitchen-garden ought to be as near the farm-houses as may be, in order to save the carriage of dung to it, and of green food to the cattle.

There is one accommodation of a farm I relish greatly, because it has a charitable view. Why not reserve work for superannuated labourers that requires

requires little strength, cutting down weeds for example, weeding hedges, filling up ruts in a road with small stones, tending cattle in the house during winter, gathering dung, and such like? Half-pay would help them to live; and gentle work would keep them in spirits, preventing a langour that sits down heavy on the industrious, when reduced to idleness.

It will not be an unnecessary addition, to examine what sort of farm is proper for a wright, a smith, a mason, or a weaver. A mechanic, it is true, makes more by his art than by husbandry-work: but if he have no farm to depend on, he must go far to market for provisions, and will be ill provided after all. At any rate, he must have a small farm for maintaining a horse and two cows: the former for carrying timber, iron, coals, &c.; the latter for milk.

The quantity of land necessary for supplying all his wants, cannot be less than six acres where the soil is good, and more where it is indifferent. To prevent the expence of winter-herding, the field must be inclosed; but divisions are not necessary. It ought to be cropped as follows: a third part in red clover, with a small proportion of ryegrass to thicken the crop: a third part in oats, turnip and potatoes; the remaining third in barley and lint; the lint to be sown where the potatoes grew the former year.

To

To save the expence and trouble of carrying clover to the cattle in the house, and of carrying dung to the field, let a moveable trough be provided twelve feet long, the side spars eighteen inches high. Bind the horse and two cows to stakes at the side of the trough, and let them have plenty of clover. To defend them from heat and from flies, cover them with a shed, the roof of which may be an old sail, or any other coarse cloth, supported upon wooden pillars. The trough and shed moved from place to place, will spread the dung equally, and save carriage of the clover. The wife or maid-servant, when she milks the cows, fills the trough with clover; and the richness of the food will make it proper to milk them thrice a-day. The oat and barley crops need no instruction. The turnip is an excellent food for the cows in spring after calving; and there ought to be as many potatoes as to serve the family the year round. As for the flax, all the ground that can possibly be spared ought to be cropped with it; because every person of the family may be profitably employed, upon dressing it in winter-evenings when no other work is on hand, and when otherwise they would be idle.

The oat and barley straw, with what clover has been saved, will suffice for winter-food to the horse and two cows. And the dung that can be thus gathered, will suffice for the turnip and potato

tato crops. As the lint succeeds the potato crop, it will require no dung.

The great loss of a small farm that cannot maintain a plough is, that the land is never dressed in season. No neighbouring farmer will part with his plough, even for hire, till his own work be finished. This loss may be prevented by placing two mechanics together. If good-natured and sociable, they will go on pleasantly with their two horses in a plough, and will have always the season at command for plowing. The great advantage of such a plan, both for frugality and profit, will subdue even bad humour, and make the neighbours go on cordially together.

With respect to a weaver, some Irish pamphlets declare against his having any land to cultivate; for the reason above mentioned, that there is more profit by weaving than by farming. But this reason is not satisfactory. Weaving, a sedentary occupation, requires at times field-labour for sake of health; and it is not consistent with humanity, that profit only should be the object, without regard to health or comfort. It may at the same time be doubted, whether upon the whole it will not be profitable to preserve a weaver a few years longer in health and vigour. These considerations must weigh, even where there is a market at hand for provisions, which is a rare case in Scotland. But as a weaver has no occasion for a horse, four acres are sufficient for his

his purpose, to be cropped in three divisions as above-mentioned.

C H A P. XIV.

WHAT A CORN-FARM OUGHT TO YIELD
IN RENT.

IN leasing a farm, it appears an equitable bargain, that after a moderate allowance to the tenant for his skill and industry, and after deducting the expence of management, the remainder of the product, or its value in money, ought to go to the landlord as rent. In order then to ascertain the rent of a farm, the particulars must be stated with which the crop ought to be burdened. This will be found not an easy task : but the following considerations, will pave the way to it.

The labour bestowed on dressing land for a crop, is evidently a burden on the crop. But by what rule is that labour to be estimated ? If the labour of every man and every horse were allowed to the tenant at so much *per* day, it would encourage him to loiter, instead of being diligent : the crop would be exhausted by the expence, and nothing be left to the landlord. The nature of the agreement between landlord and tenant, suggests a more proper method of stating the account. The tenant furnishes the servants and cattle ;

cattle ; but as they labour for the landlord, the expence must be defrayed by him. The article for servants hired by the year or half-year, is simple : their wages must be stated as a burden on the product. The article for the labouring cattle is more intricate. Were the price of every beast to be stated, bought by the tenant during his lease in place of those that fail, it would occasion much trouble, and open a door to fraud. The only practicable way, is to allow the tenant a yearly sum, for the use of his cattle, and for upholding them. For the former he cannot be offered less than five *per cent.* ; because that sum he would be intitled to, upon converting his stocking into money. As to the latter, cattle are a perishable commodity ; and every farmer reckons upon the expence of renewing his stock every ten years. To answer this expence, the tenant ought to be allowed yearly ten *per cent.* of the value of his stock ; which sum in ten years amounts to no more but that value. But this is not all : a poor tenant who commonly has nothing to depend on but his stock, must be preserved from risk. His stock of labouring cattle ought to be insured to him ; and the insurance cannot well be yearly under four or five *per cent.* Upon the whole, for furnishing labouring cattle, and upholding them, he is well intitled to twenty *per cent.* yearly of their value ; and this sum is another deduction from the yearly product.

In

In this account must also be comprehended the farm-instruments, ploughs, carts, &c.; for these must be renewed from time to time, still more frequently than the labouring cattle. But cows and calves, and other particulars that are kept for the benefit of the tenant solely, are not to be comprehended; because they produce nothing to the landlord.

What the tenant himself ought to be allowed out of the product, for bestowing his whole time upon the service of his landlord, is far from being obvious. A tenant is in a higher class than a hired servant or day-labourer; and may well rank with a shop-keeper in a town, or a manufacturer in a village. To judge by that comparison, his allowance ought not to be under L. 36 or L. 40 yearly; supposing the corn, one grain with another, to give ten shillings *per* boll, which is the price to be understood in every branch of this inquiry. Nor is this a high allowance, considering that after maintenance of the family, and education of the children, very little will be saved. But here nature strikes out against this allowance. Men are ambitious of power, the lower classes not excepted. Every day-labourer who has saved a little money by penury, immediately commences farmer. He purchases his labouring cattle upon credit, and depends on his little stock for what else he wants. What tickles him, is not independence only, but to have the command of ser-

vants and horses. Many a poor man is involved thus in difficulties, who lived more at ease while he was a day-labourer. One acquainted with this scene, would be amazed to hear, that in many places of Scotland, there are two, three, sometimes four, tenants about a single plough, in a poor farm that perhaps does not pay L. 5 yearly. Were it not the ambition of being tenants, better it would be for them to labour at 8 d. *per* day. By this ambitious propensity in my countrymen, much less is made by farming, than the tenant is intitled to from the nature of his profession. It is believed, that those who are confined to one plough, do not at a medium clear more than L. 20 yearly; which exceeds not the wages of an ordinary mechanic, and is not far above what a day-labourer earns. The landlord indeed appears to profit by this propensity; because the less that is drawn of the product by the tenant, the more is left to the landlord: but the profit is only imaginary; for the landlord suffers in the main by the risk he runs of weak tenants. Men of prudence, find it their interest to keep their farms low for the encouragement of more vigorous tenants.

However this be, the rent of small farms determines the rent of every farm; for a landlord, who draws of rent L. 80 from two small tenants, will not easily be persuaded to set both farms to one tenant for L. 75. But it falls out luckily here,

here, that there is encouragement to great tenants, without encroaching on the landlord's interest. A lease of six small farms will intitle him to the share of each of the former possessors, which is L. 120, without lowering the landlord's rent one farthing.

I need scarce mention, that the expence of seed is a burden upon the annual product; as also the expence of reaping, threshing, &c. as far as these articles are performed by strangers hired for that purpose. And to save a vague account, a lump sum ought to be stated for these particulars.

It falls in here to be considered, whether the nature of the soil, good or bad, make any difference upon the tenant's share of the product. One thing is evident, that if he be not enabled to live by his farm, he must take himself to some other occupation; and to live with any degree of comfort, less he cannot have than L. 20 yearly, however mean the soil may be. On the other hand, he is intitled to no benefit from the fertility of the soil; because it adds neither to the expence of culture nor of living. Fertility is a quality of land; and a subject belongs to the proprietor with all its qualities. As fertility depends not on the tenant's skill nor industry, he is intitled to no benefit from it.

For the same reason, any saving in the expence of culture ought to benefit the landlord only; as
where,

where, by the construction of a plough, two draught-horses are sufficient instead of three or four : or where oxen are used instead of horses: the gain of the tenant is not lessened by such savings.

On the other hand, where a tenant, by superior skill or extreme diligence, raises on an acre a bushel more than usual, the profit ought to be his own : it is owing to himself, not to the fertility of the soil.

Lastly, Suppose a lime-quarry, or a bed of shell-marl, to be discovered within a farm, or near it, it ought to be considered as an article for the landlord, in giving a new lease. The profit ought to be his, stating only an allowance to the tenant for the expence he lays out upon the manure. It is in effect adding to the fertility of the soil ; which, for the reason above given, ought to benefit the landlord only.

Let us illustrate these general views, by stating an account of particulars. Take a farm of sixty acres ; which being partly in pasture, may be managed by a single plough with four horses. I begin with computing the rent of such a farm, where the product in corn and grass is at a medium equal to the value of five bolls *per* acre, or 50 s. amounting upon the whole farm to L. 150. Add the profit of ten winterers fed with straw, which may be stated at L. 5. The whole sum drawn out of the land is L. 155 ; from which is to be deducted

deducted the tenant's share, and every other article of expence: the balance is the landlord's rent. Let us enter into the several articles of deduction.

First, The seed, which shall be stated at L. 20 only, as a part is in pasture.

Second, The fifth part, or 20 *per cent.* of the value of the labouring stock, which stock by computation is L. 74, 10 s. *. *Inde*, L. 14, 18 s.

Third, The farmer's share L. 20.

Fourth, As the farmer himself may stand for one servant, I state only the wages and maintenance of another L. 12.

Fifth, The maintenance of the four horses L. 24.

Lastly, The money paid for reaping, threshing, &c. lumped at L. 8.

These deductions amount to L. 98, 18 s. But if the land can be managed with two horses, the deductions will amount to L. 82, 2 s. only, beside saving a driver.

* Four horses	-	-	L. 48	0	0
Horse-furniture	-	-	2	0	0
Two ploughs	-	-	2	0	0
Carts and wains	-	-	14	0	0
Harrows and brake	-	-	2	0	0
Roller	-	-	1	0	0
Fanner	-	-	2	0	0
Forks, spades, scythes, rakes, wheelbarrows, hooks, &c.	-	-	1	10	0
Twelve harden sacks	-	-	2	0	0
			74	10	0

N. B. Reparation of houses, and other small articles, are too minute to enter into a general view. But if any article be thought too high, they may serve to balance what is subtracted from that article.

The account then stands thus. On the one hand the product - L. 155 0 0
Subtract on the other hand - 98 18 0

56 2 0
This balance of L. 56, 2s. is the landlord's rent.

Supposing the product to be but four bolls *per* acre, or 40s.; *inde* the product L. 125 0 0
Subtract as before - 98 18 0

Rent L. 26 2 0

Supposing the product to be $3\frac{1}{2}$ bolls *per* acre, or 35s.; *inde* - - L. 110 0 0
Subtract - - 98 18 0

Rent L. 11 2 0

Here an unexpected discovery is made of great importance in farming; which is, that a farm yielding no more but an average of $3\frac{1}{2}$ bolls *per* acre, had better be wholly set for pasture. For supposing it in that shape to yield no more but 5s. *per* acre, which is L. 15 for the whole, the

the clear profit is greater than when the farm is in corn; and the landlord draws more rent: he draws the whole L. 15, as land set in pasture is not burdened with any expence. This discovery may be of use to many a poor tenant, who labours and toils at the plough from year to year, to his own loss. If his farm produce not more than $3\frac{1}{2}$ bolls *per* acre, better abandon the plough, turn his farm into pasture, and sit idle.

But if a tenant can reduce his labouring cattle to two horses or two oxen, the saving will be so considerable as to make it his own interest as well as that of the landlord to continue his corn-crops. The saving amounts to L. 16, 16 s. yearly, not to mention the driver; which throws the balance against pasture no less than L. 12, 18 s. supposing the farm in pasture to yield but 5 s. *per* acre. This saving benefits the tenant during his lease, and benefits the landlord in giving a new lease. But supposing the product to be but 3 bolls *per* acre, the balance turns clearly for pasture, after every saving that can be made when such a farm is in corn.

At the same time, however fertile the soil may be, the man who takes in lease a made farm, cannot expect more but to live comfortably. If his heart be set on wealth, it is not to be found but in land recently broken up from the state of nature, where there is scope for great and lasting improvements.

This

This speculation ought to be a ruling motive with every gentleman of a land-estate, to encourage improvements with all his might. The expence of culture is not less in a mean soil than in the most fertile; and we now see, that the expence of the former cuts so deep into the corn-product, as to leave little or nothing to the landlord. In our corn-counties, it is not difficult, nor extremely expensive, to make the land carry two or three bushels *per* acre more than the ordinary product; the value of which goes entirely to the landlord as rent.

Upon a review, the only doubtful article is the *5 per cent.* stated for ensuring the tenant's labouring cattle. It appears to me, that a yearly sum precisely equivalent to the chance of losing cattle, is not sufficient; for if the chance go against the poor tenant, he is undone. Something for insurance he ought to have; more or less is arbitrary. But supposing it to be *3 per cent.* or *2* only, it will be easy to frame the computation upon that supposition.

PART

PART II.

THEORY OF AGRICULTURE.

THE operations of men can be easily traced : they are confined to the surface of bodies. The operations of nature, going far out of sight, reach even elementary particles. In explaining therefore natural effects, we ought to rest satisfied with the immediate causes, leaving the more remote to superior beings. In order to unfold the theory of agriculture, the nature of plants ought to be studied, their nourishment, their propagation : we ought to be acquainted with all the different soils, and in what manner they are affected by weather and climate. And yet, after all our researches, how imperfect remains our knowledge of these particulars ! Fortunately, agriculture depends not much on theory. If it did, baneful it would be to the human race : skilful practitioners would be rare ; and agriculture, upon which we depend for food, would, by frequent disappointments, be prosecuted with little ardour. Notwithstanding therefore that the theory of agriculture is still in its infant state, the practice has made considerable advances, especially in Bri-

tain; and there are rules founded on experience, that seldom mislead when applied by a sagacious farmer. In theory, the deepest penetration preserves not writers from wide differences. In practice, the ignorant only differ : sagacious farmers generally agree ; giving allowance only for varieties in soil and climate.

But admitting experience to be our only sure guide, theory however ought not to be rejected, even by a practical farmer. Man is made for knowledge ; and he has a natural curiosity to learn the reason of every thing. Why not indulge an appetite, that will amuse, and may bring forth instruction ? In dipping into theory, a complete system is far from my thoughts, and far above my reach. I venture only to select a few particulars, that have an immediate influence on practice. These will be understood by every gentleman who joins reading to experience ; and in doubtful cases may help to direct his operations. I give warning before hand, that I pretend to no demonstration. However positively I may happen to express myself in the glow of composition, my best arguments are but conjectural. Those that are here displayed appear to me highly probable ; and if they appear so to the reader, I can have no farther wish.

The subjects handled in this part of my work, are divided into three chapters. In the first are contained

contained some preliminary observations that have an immediate influence on practice. In the second are handled the food of plants, and fertility of soil. And the third is upon the means of fertilizing soil.

CHAPTER I.

PRELIMINARY OBSERVATIONS.

TO be an expert farmer, it is not necessary that a gentleman be a profound chemist. There are however certain chemical principles relative to agriculture, that no farmer of education ought to be ignorant of. Such as appear the most necessary shall be here stated, beginning with elective attraction and repulsion, which make a capital article in the science of agriculture as well as of chemistry.

I. ELECTIVE ATTRACTION AND REPULSION.

By an inherent quality of matter, every particle of it has a tendency to unite with every other particle ; and this tendency is termed *gravity*. Beside gravity, inherent in all matter, there is in some bodies a peculiar tendency to unite together ; acids and alkalies for example,
air

air and water, clay and water. The particular bodies thus disposed to unite, may be termed *corresponding bodies*; and as such disposition or tendency has a resemblance to choice in voluntary agents, it is termed *elective attraction*.

The power of gravity extends as far as matter exists. Elective attraction, on the contrary, is confined within a very narrow space: it operates not but between bodies in contact, or approaching nearly to it.

Even in the largest bodies, such as the sun and planets, every particle of matter operates by its power of gravity. But elective attraction has no sensible effect between large bodies, no particle operating but those in contact, or near it. It has no sensible effect therefore but between bodies that mix together. The attraction of gravity between two bodies is in the direct proportion to the quantity of their matter: elective attraction is in the inverse proportion; which in plain language is saying, that the less bodies are, the greater is their elective attraction. Between large bodies accordingly, elective attraction in opposition to gravity is as nothing: between very small bodies in contact, or near it, it is far superior to gravity.

The power of gravity in each particle of matter corresponds to the quantity of matter in the universe: double that quantity, and you double the
power

power of gravity in every particle : annihilate the half, and the power of gravity is reduced to the half. Elective attraction, on the contrary, is invariable. It can hold but a certain quantity of corresponding matter : bring more within its sphere of attraction, it has no effect. Thus, water will hold salt till it be saturated ; or, in other words, till every particle of the water be in contact with a particle of salt. Add more salt : it is not attracted, but falls to the bottom of the vessel. The same is observable in clay saturated with water : what water is added falls to the bottom.

Elective attraction between some corresponding bodies, is more vigorous than between others. Acids and alkalies attract each other violently, and mix intimately. Such is the case also of salt and water : salt is so thoroughly dissolved in water as to vanish out of sight, leaving the water transparent as before *. There is an elective attraction between air and water : neither of them in
its

* We have Sir Isaac Newton's authority, that the opacity of a body is owing to the reflection or refraction of the rays of light at its surface ; and that the particles of a body must be of a certain size to reflect or refract the rays of light. A body composed of smaller particles, is transparent. Water, composed of very small particles, is transparent : throw salt into it, it maintains its transparency, having the power to dissolve salt into very small parts ; and the same happens with respect to any other substance that is dissolvable by water into very small parts.

its natural state is ever found pure without the other; and yet their mixture seldom disturbs their transparency. In the instances above given, elective attraction prevails over gravity, which has not power to separate the heavier body from the lighter. Water and clay attract each other, but with less vigour: powdered clay is suspended in water; but the elective attraction is not so strong as to dissolve the clay into its smallest parts: it continues visible in the mixture, and makes the water turbid. Their mutual attraction yields by degrees to the repeated impulses of gravity: the clay subsides, leaving the water transparent as originally. But each particle of clay draws along with it the particles of water with which it is in contact. And accordingly when the water is poured off, the clay remains moist and soft.

Both air and clay attract water; and when they act in opposition, it is of importance to know which of them prevails. Where clay is so wet as that many particles of the water are not reached by the attraction of the clay, such loose particles are attracted by the air without opposition. Even particles of water, barely within the sphere of attraction of the clay, are drawn up by the superior attraction of dry air. But the air must be both hot and dry, to carry off water that is in actual contact with the clay. This I conjecture never happens in pure clay, unless the heat be intense.

All

All sorts of earth do not attract water equally : the attraction of clay is the strongest, of sand the weakest. Between these extremes, soils vary in every degree with respect to their power of attracting and holding water. Even clays differ. Some clays attract water vigorously, others less. This is manifested from the time that is taken in drying ; as the clay that attracts the most vigorously will be the latest in parting with its water. I witnessed an experiment of different clays put in shallow vessels, and soaked with water. They differed in the times of drying at least a fortnight. I take it for granted, that the clay which retains its water the longest, will turn the hardest after it is dry ; for both effects depend on the force of the elective attraction.

It is laid down above, that elective attraction is the greatest between the smallest bodies. Hence an important lesson in agriculture, which may be justly esteemed the corner-stone of the fabric, that the more pulverized earth is, the more water it will hold. A lump of dry clay immersed in water, carries none away but what is attracted by the surface-particles. Pulverize this lump, and give free admission to the water ; let it be divided into a million of parts or into ten million : each particle however minute will hold a certain proportion of water ; and this process may be carried on as far as clay and water can be divided
by

by the hand of man*. It is amazing what a quantity of water may be contained in clay well pulverized, without even appearing moist. Shell-lime requires at least its own weight of water to flake it perfectly; in which state it is a dry powder without any appearance of moisture. Clay well pulverized is similar: every particle of it attracts a particle of water; and after perfect saturation, it still appears dry. This I conjecture to be the properest condition of ground for throwing seed into it. Now as earth serves to retain moisture, and to furnish it gradually to its plants, the chief object of husbandry is, by plowing and harrowing, to pulverize clay, and every other soil that requires it.

There is also observable an elective attraction between earth and air. Much air is found in earth, because gravity concurs with the elective attraction to bring down air. But very little earth is found in air; because in that case gravity counteracts the elective attraction.

A plant attracts air and water, and is attracted by them. The latter attraction is without effect, because plants are fixed to a place. The former is clearly displayed by Dr Hales in his statical essays, containing the best conducted experiments that

* Mr Evelyn dug a deep hole in the ground, reduced the earth to powder, and put it back into the hole. After a time, the powdered earth was found moist to the bottom, the ground round it remaining hard and dry.

that are known, next to those of Sir Isaac Newton upon light and colours. There is not the slightest evidence, that plants attract any dry matter, however pulverized. Set the most healthy vegetable in dried earth, or in dust gathered from the highway: it dies, and the earth remains as weighty as before. It is clear then, that a plant can receive no nourishment but what is conveyed to it by air or water; and consequently that nothing can serve as its nourishment but what is soluble in these elements. Earth is not soluble even in water: it is easily separated from water by the force of gravity; and its particles are probably too gross to enter with water into the mouths of a plant.

Black bodies attract and absorb rays of the sun. A black wall facing the sun, is hotter even to the touch than a wall of any other colour; and hence the practice of blacking fruit-walls. Soil made black by high culture, attracts and absorbs rays of the sun in plenty; and turns remarkably hotter than soil of any other colour.

That there is a mutual attraction between particles of water, appears from the globules it forms itself into in falling; from the globules it forms itself into when dropt gently upon a dry board; and from its rising above the brim when gently poured into a glass. But I am uncertain whether there be any elective attraction between particles of clay: put dry powdered clay into a vessel,

fel, and prefs it together at pleasure ; it comes out with little or no cohesion. Water is the cement that hardens particles of clay into a solid lump ; and it is in the properest state for hardening, where every particle of the one is in contact with a particle of the other. Where there is more water than to admit of such mutual contact, what superabounds is carried off by the air in its ordinary state of dryness. But to carry off any particle of water in contact with a particle of clay, strong clay especially, a very dry air is requisite, and perhaps also a very hot air. The reason is, that water is attracted more strongly by clay, than by air in its ordinary state. A green turf from a moist soil, falls to pieces in handling. Let it lie a few days to dry, it becomes tough and firm. The like happens in a mixture of quick lime, sand, and water. The water continues for a time fluid ; and the mass is soft and ductile. Upon evaporation of the superfluous moisture, the elective attraction operates ; and the mass turns hard like a stone. A mixture of clay and sand moistened with water, continues long soft ; but in time turns exceedingly hard : the pier of Eyemouth in Berwickshire is built of a plumcake stone, composed of pebbles, clay, and sand, cemented with water ; yet no stone is harder, nor less affected with the sea-air. Plaster of Paris is composed of gypsum and water ; which are mixed together to a certain consistence ; and the

the mass, still fluid, is poured into a mould : in a few minutes it acquires a stony hardness. A composition of that kind is used for bridges in the island Minorca : no sooner is one stone of the arch joined to another, than it bears a man to add a third. The cement here operates almost instantaneously : water operates slower in hardening clay ; and still slower in hardening a mixture of lime and sand.

These differences depend probably on the more or less vigour of the elective attraction. As the superfluous moisture evaporates, the corresponding bodies approach nearer and nearer to each other, and at last unite in one mass. The evaporation is slow in proportion to the vigour of the elective attraction ; and the slower the evaporation is, the mass becomes the harder. Some sorts of clay attract water more vigorously than others ; and when the superfluous moisture is exhaled, which is done very slowly, the mass turns hard in proportion. Carse-clay affords a good instance. It is composed of the finest parts of natural clay, washed off by running water : it is deposited in flat ground where the water stagnates ; and by gradual accumulation, the ground rises above the stream. Carse-lands are generally near the sea, and the reflux of the tide contributes to the effect. By the minuteness of its parts, carse-clay mixes so intimately with water as to give the elective attraction its utmost efficacy.

cacy. Thus carse-clay, which is extremely wet in winter, becomes so hard in a drouhty spring as to yield but a very scanty crop, unless the summer be moist. In a dry summer, fissures are every where seen in it, some of them so wide as to admit a man's hand. Common clay, composed of grosser parts, never hardens so much. Hence it is, that of all crops beans thrive the best in carse-clay: the tap root pushes vigorously into the hard soil; and finds more water locked up there than in common clay*.

This tendency to hardness in clay-soil, is a great obstruction to fertility; and to counteract that bad quality, I know no means more effectual than frequent plowing and harrowing. In that view partly, the harrows above described were invented: they divide the soil into minute parts: every part holds a particle of water ready for the nourishment of plants; and the soil at the same time is

* The clay in the Carse of Gowry, of Falkirk, and of Stirling, is much of the same nature. When dry, it is white, less weighty than common clay, pure without sand, and divides into very minute parts. The last-mentioned quality, which gives elective attraction its greatest efficacy, makes it cake at the surface when stirred before winter. It makes it also in drought unite into very hard clods, harder than those of common clay, composed of grosser parts. As all clays hold water in proportion to the minuteness of their parts, frost acts more vigorously upon carse-clay than upon the ordinary sort; because frost acts upon bodies in proportion to the quantity of water in them.

is kept open, inviting the roots to extend themselves in all directions.

The time that water takes to harden clay, will explain several articles. I mention first an article of importance, which is the different effects of plowing clay wet or dry. The running a plough through clay soaked in water, produces no change. Upon evaporation of the looser parts of the water, the vacuities left render the soft mass compressible. To compress it in that state would have the effect to keep in the remainder of the loose water from evaporating, at the same time give the elective attraction its strongest effect, and accelerate the hardening contrary to the very intention of plowing. Let not the plough be applied till the air has performed its part by drawing off every particle of water that is not in contact with the clay. Nick that minute for applying the plough: the clay still soft is easily divided: a new surface is laid open to the air; and at the same time is preserved free and open.

The next article I shall mention, is the making brick. Where air and water are brought into contact by elective attraction, the process is completed: for they never harden into a solid body. But after clay and water are brought into contact, the process goes on till they be firmly united. In the commencement of that process, the air may be rendered so hot and dry, as to overcome the elective attraction, and suck up the whole moisture,

moisture, leaving the clay dry with little or no cohesion. Wet clay put into a hot fire, does not harden, but falls into a burnt powder. The superfluous moisture must be evaporated, and the cohesion be considerably advanced, before it can be hardened into a brick by fire. In that condition, the elective attraction prevails over the hottest air. Form dough into a thin cake, and lay it upon a plate of iron over a fire : the moisture suddenly evaporates ; and no more is left but what is barely sufficient to keep the parts slightly together. Give the elective attraction time to operate : the cake turns hard like a brick*.

Nature operates by elective repulsion as well as by elective attraction ; but as agriculture seems to depend little upon the former, I shall say but a word upon it. There is an elective repulsion in the particles of air, which gives them a tendency to recede from each other ; and this operation is greatly

* With respect to brickmaking, where the mould is nine inches long, three broad and three thick, a brick new moulded weighs commonly eight pounds : ready for the oven, four pounds : half burnt, three pounds 12 ounces : when thoroughly burnt to be fit for use, three pounds eight ounces. This lesson is of importance. If proper clay be chosen, a man cannot be deceived about the quality of his bricks. A bargain to pay for no bricks that weigh above three pounds eight ounces will ensure him. A smaller sum may be agreed on for what weight a little more ; which may be sufficient for any building that is not exposed to the external air.

greatly invigorated by heat. Heat therefore pulverizes the soil by rarifying the air contained in it, which moves the particles of earth out of their place. Frost has a similar effect, by rarifying the water contained in a soil. Black, as observed above, attracts and absorbs rays of the sun; and therefore black is the best colour of soil. The more parts clay or loam is divided into, the blacker it is. Whatever be the colour of the soil where potatoes are set, it is rendered black by that crop. A potato-crop is a powerful pulverizer: the bulbous roots swelling without intermission, keep the surrounding earth in constant motion, and divide more effectually than a plough or a harrow. White repels the rays of the sun; and upon that account is a bad colour for soil. Pulverizing by dunging, plowing and harrowing, is a sure means to convert white soil into black; which is an additional motive for being diligent in these operations.

2. PLANTS HAVE A FACULTY TO ACCOMMODATE THEMSELVES TO THEIR SITUATION.

ALL trees are provided by nature with a tap-root, fit for piercing the hardest soil; and a tree growing in clay exerts great energy on that root. It lessens in vigour and size where a tree grows in loam; and lateral roots prevail more, which are spread

spread all around for procuring food. In very light soil, the tap-root is very small; and a tree growing in water has many roots, but not the least appearance of a tap-root. Nature is wonderful in all her works. A plant here acts as if endued with the sagacity of a thinking being: in this instance, and in many that will be unfolded afterward, vegetable life seems to be not far remote from animal life.

The constitution of a plant depends greatly on the soil it is bred in. Custom becomes a second nature; and it appears no less difficult, to transplant a tree from the soil where it was reared to an opposite soil, than to transplant a tree from a hot to a cold climate. However fitted by nature a tree may be for growing in a loose soil; yet if planted young in a stiff soil, it requires a constitution accommodated to that soil; and its nature is so far altered, as in a measure to disqualify it for being transplanted into a loose soil. Take a vegetable that has been reared in water, and plant it in a soil even the most proper for it by nature: it will infallibly die. In general, plants reared in water will not grow in earth; and plants reared in earth will not grow in water. Hence it is, that where water stagnates ten or twelve inches under the surface, the plants reared in that ground turn sickly when their roots reach the water. Yet these plants would have flourished in pure

pure water, had they been accustomed to it early.

But may not a plant acquire a constitution, fitting it for growing partly in earth, partly in water? Trees grow vigorously on the brink of a river, where some of the roots must be in water. At the seat of Mr Burnet of Kemnay, ten miles from Aberdeen, a kitchen-garden, a flower-garden, a wilderness of trees indigenous and exotic, are all in a peat-moss, where water stagnates from one foot to two under the surface.

The same faculty is exerted to remedy an inconvenient situation. A tree that grows without shelter, resists wind by the length of its roots: the roots of the same tree, are commonly much shorter in a sheltered place. In the Leeward islands, the east wind is almost constant; and the trees there, extend their roots much farther to that quarter, than to any other. A tree overtopped by neighbouring trees, directs its course to a space that is free; and then mounts up perpendicularly according to its nature. Set a plant in a room that has no light but from a single hole in the wall: instead of rising perpendicularly, it directs its course toward the light, passes through the hole into open air, and then mounts upward. The power of remedying a bad situation, is remarkable in seed of every kind. A seed contains the plant in miniature, with a *plumula* that tends upward, and a *radicle* that tends down-

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ward. Put a seed into the ground with its plumula above and its radicle below as the plant grows, the former ascends and the latter descends, both perpendicularly. Invert the position of the seed, the plumula shoots not downward, nor the radicle upward: they twist round the seed, till the former gain the open air, and the latter pierce into the ground. Providence is wonderful in every operation: were not provision made for the springing of seed in every position, agriculture never could have made any progress *.

A change of constitution, in plants, occasioned by their situation, is commonly transmitted to their offspring. Plants propagated from seed produced in a warm sandy soil, grow fast in whatever soil the seed is sown, and have early flowers. Plants from seed produced in a cold stiff soil, are late of growing, even in a warm soil. Plants from seed produced in a very rich soil, grow vigorously in a poor soil. Plants from seed of a poor soil, grow weakly even in the richest soil, and produce small seed. In the rainy harvest 1744, oats that grew in a warm light soil, sprouted in the shock ten days more early than oats that grew in a cold soil; though both were produced from the same seed, and both were cut down the same day. Hence the advantage of changing seed from a warm to a cold soil. It may be true, that seed from

* See more about the powers and faculties of plants, Appendix, No. 4.

from a warm soil will not grow so quickly in a cold soil as in a warm soil ; but it will always grow more quickly than seed from a cold soil. To rear trees in a middling soil, it is certainly right to take the young plants from a richer soil. But is it right to transplant them from a rich soil to one that is poor ? They have, it is true, a tendency to grow vigorously. But will they not be dwarfish in the poor soil, which cannot afford them sufficiency of nourishment to support their vigour ?

That a plant may change its constitution by being transplanted into a climate a little warmer or colder, is certain ; and the change of constitution is still more easy when the plant is raised from seed. Thus plants of one climate may, by gradual change of place in successive generations, prosper in a very different climate. When Galen the physician lived, the peach was too delicate for the air of Italy. It has been creeping northward slowly ; and, even in Britain at present, it is of a good flavour, if artfully cultivated. The cherry tree was brought by Lucullus from the Lesser Asia to Rome, as a great rarity ; and now it bears good fruit even in Scotland. The blessings of Providence are distributed with an equal hand. Industry will remedy the natural defects of our soil and situation : are we less happy than those who owe all to soil and situation ? If wheat, if fruits, if cabbage, if collyflower, were confined

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to their native climates, what would Britain be? Iceland would be not much inferior *.

But though a change of constitution is produced as far as necessary for accommodating a plant to a different climate, yet it is observable, that in other respects the original constitution remains entire. I give for one instance the flowering of plants. A plant translated into a different climate, preserves its original season of flowering, unless prevented by some powerful cause. The climate of the shores of Spain and Portugal, suits the flowering of the *laurustinus* in December and January; nor is the cold of Scotland in these months sufficient to deter him from his season. I mean the milder parts; for in those that are higher and more rigorous, the cold puts him past his season, and prevents his spreading any flower till April. Dr Walker says, that were he to see a *laurustinus* flowering with us in winter, and had never heard of the shrub, he would without scruple pronounce it no native of this country; and that for the same reason he would deny the

* Columella, book 1. chap. 1. quotes from Salserna the following argument to prove an alteration of climate. "Countries where neither the vine nor the olive would grow from the severity of the winter, abound now both with wine and with oil." It is natural that this should have appeared to Columella a conclusive argument; for in his days there was little experience of plants changing their nature in their gradual progress from hot to cold climates,

the *arbutus* to be a native of Ireland, or the whin, of Scotland. He adds pleasantly, that the flowering of these shrubs with us, is an outlandish fashion; and that no sensible Scotch plant will ever think of such a thing.

3. CHANGE OF SEED, AND OF SPECIES.

THE reason for changing seed from a warm to a cold soil, is explained in the foregoing section. But skilful farmers are not satisfied with that single change: they frequently change seed from a cold to a warm soil; and they seldom venture to sow twice successively the same grain in the same field. Such changes of seed, as well as of species, are common; yet I know not that the reason has been rightly explained by any writer. I wish that what follows may give satisfaction.

Every species of animals has a climate adapted to it, where it flourishes, where it grows to perfection, and where it never degenerates. Propagation will go on in a less proper climate; but the species degenerates, if not kept up by frequent recruits from the original climate. In that view, Arabian and Barbary horses are from time to time imported into England. Nor is this alone sufficient: animals procreated of the same breed quickly degenerate; for which reason, great attention is given to mix different breeds. In these particulars, plants resemble animals. Britain

tain is not the native climate of melons : they degenerate quickly, if seed be not procured from the native climate. Where wheat grows naturally, seed dropping from the mother plant arrives at perfection, though neither seed nor soil be changed. But as wheat is not a native of Britain, it has a tendency to degenerate here, especially in the northern parts ; and it degenerates rapidly, if the seed be sown year after year where it was produced. It is not sufficient, that the seed be taken from a different field : it ought also to be taken from a different soil. Nor is this all : the greatest care in changing seed will not prevent degeneracy, where the same species is successively propagated in the same field. It is accordingly a rule universally practised in cropping a field, not only to bring seed from a different soil, but also to change the species ; or, in other words, to make a rotation of crops. This rule holds in barley as well as in wheat ; and still more in red clover, which degenerates quickly when sown without intermission in the same field. It is more common to sow oats after oats ; and if that plant be a native of Britain, the practice may escape censure, especially if care be taken to change the seed. White clover is a native of Britain, and requires little precaution in cropping. By Tull's mode of husbandry, tolerable crops of wheat have been raised in the same field, fifteen or sixteen years successively ; but toward the end, the degeneracy became visible. Artful culture
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will do much ; but it is not alone sufficient to prevail over the laws of nature. This is an objection to Tull's husbandry, which that ingenious author did not foresee. His mode however ought not to be totally rejected : to raise by artful culture, without manure, ten or twelve crops of wheat successively in the same field, is a capital improvement in farms where manure is scarce.

The degeneracy of plants and animals in climates where they are not natives, depends on causes beyond the reach of human investigation. But to a person whose curiosity is not boundless, it may be sufficient to observe, that if every species of animals and plants have a climate fitted for them, there is no reason to expect perfection in an improper climate *.

If what is said hold true, an extensive rotation of crops in the same field must be good husbandry. In a clay soil, constant crops of wheat after fallow without change of species, is in England not uncommon. I should imagine, that in Scotland

* In the same field, all equally dressed, a firlot of Blainly oats was sown ; and clost to it the like quantity of good oats produced in the farm that had not been changed for some years. Four bolls, two pecks, two lippies, were the product of the former. The corn weighed at the rate of 14 stone ten pounds *per* boll, and the straw 96 stone. Three bolls, two firlots, one peck, were the product of the latter. The corn weighed at the rate of 13 stone two pounds *per* boll. And the straw weighed 80 stone.

land wheat every other year in the same field, would degenerate. There is an additional reason against that practice, that it requires a larger stock of working cattle than a more varied rotation. A skilful farmer cultivates his wheat-land in October, his beans in January, his oats in March, his barley in April or May, and his turnip in June or July, all with the same cattle.

The particulars above set forth, are what I judge the most essential in the theory of agriculture, and what will be found necessary for understanding the subjects handled in the following chapters. Many other particulars, less extensive though perhaps no less essential, are introduced where there is occasion for them. Upon the whole, in order to ease the reader, I have avoided every article of theory that is not closely connected with practice, such as a gentleman may be ignorant of, without suffering the imputation of being an unskilful farmer.

C H A P. II.

FOOD OF PLANTS, AND FERTILITY OF SOIL.

IN no branch of philosophy are imagination and conjecture more freely indulged, than in what concerns the food of plants. Every writer

ter erects a system : if he can give it a plausible appearance, he inquires no farther. It never enters into his thoughts, that his system ought to be subjected to the rigid touchstone of facts and experiments : so grievous a torture he cannot submit to. This reflection will be justified by what follows. And to pave the way, the method chosen by nature for feeding plants shall be premised.

Juices imbibed through the roots and leaves of a plant, are by an internal process converted into sap, which, not improperly, may be called the *chyle* of vegetables. Sap is in a continual oscillatory motion, ascending during the heat of day, and descending during the cold of night.

The sap of a plant is nearly the same, in whatever soil the plant grows. Homberg filled a pot with earth mixed with a portion of saltpetre : he filled another pot with pure earth well washed. The cresses that grew in these pots were entirely of the same nature, equally alkalescent ; what grew in the first pot as little acid as what grew in the second. In other two pots, prepared in the same manner, he planted fennel, an acid plant. The difference of earth made no difference in the two plants. I advance a step farther. If we can judge of sap from what of it perspires from the plant, it is nearly the same, even in different species. Dr Hales collected the liquor perspired from trees of different kinds. It was very clear ;

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its specific gravity was nearly the same with that of common water ; and no difference of taste could be perceived in the different liquors. These facts are confirmed by many other experiments ; all of them evincing, that however different the juices may be that are imbibed by a plant, yet that the sap into which these juices are converted is the same, or nearly the same, even in plants of different species. If so, every plant must be endowed with proper powers ; first, to imbibe juices ; next, to convert into sap the juices imbibed ; and last, to convert that sap into its own substance. With respect to the two first powers, all plants appear to be similar. The difference of species is carried on by the last power only, that of converting sap into the substance of a plant. Hence a peculiar texture, colour, smell, taste, in each species. “ Thus,” says Dr Hunter of York, “ a mass of innocent earth can give life and vigour to the bitter aloe and to the sweet cane, “ to the cool house-leek and to the fiery mustard, to the nourishing wheat and to the deadly night-shade *.” In what manner or by what

* Plants are distributed by nature into classes, distinguishable by a simple act of vision. Each class has its peculiar properties, which makes it easy to apply them to the purposes for which they are the fittest. Otherwise to attain any perfect knowledge of plants, would be an endless labour, and at any rate far above an ordinary mechanic. But the classes could never be preserved distinct, if the juices imbibed by plants had any influence to vary their nature.

what means the changes mentioned are produced, will for ever remain a secret: they depend on energies impenetrable by the eye, and beyond the reach of experiment. Nor ought the farmer to repine at his ignorance of such matters. The province of agriculture is, to cultivate soils in such a manner as to furnish juices in plenty: the rest must be left to nature; and may safely be left, for she never errs in her operations.

Thus prepared, we proceed to examine the most noted opinions concerning the food of plants. A number of writers hold, that oil and salt are capital ingredients in vegetable food; and that the richest soils are what contain the greatest quantity of these substances. Oil and salt are found in vegetables. "*Ergo*," say these writers, "oil and salt in the soil make the nourishment of plants." It may as well be reasoned, that as all animals have blood, *ergo*, blood is the nourishment of animals. The same doctrine applied to manures has led Dr Hunter, mentioned above, to propose a manure consisting chiefly of oil, termed by him the *oil compost*; upon which he lays great weight. Every attempt to enlighten is praise-worthy; but such attempts seldom are successful, unless to mislead the credulous husbandman. From what is said above, it may be pronounced with certainty, that the oil and salt which enter into the composition of vegetables, are not imbibed from the earth or air; but are formed

formed from more simple materials, by the internal process above mentioned. A number of plants of different kinds, may find room for growing in thirty or forty pounds of earth. Each of them has an oil and a salt peculiar to itself; though there may not be in the earth the smallest particle of either. Nay, by repeated experiments it has been found, that plants raised in water are composed of the same parts with those raised in earth. Led by the above-mentioned opinion, several writers have conjectured, that clay-marl, a potent manure, must contain a large proportion of salt and oil. But it being found on trial that it contains neither, they were reduced to another conjecture, that when mixed with the soil it attracts salt and oil from the air. And now from Dr Ainslie's accurate and elegant experiments*, that supposition appears to have as little foundation as the others mentioned.

Had due attention been given to the mouths of roots, so small as not to be discernible by the naked eye, it must have been obvious, that oil is a substance too gross for entering these orifices. Chemists hold, that all oils are composed of inflammable matter, mixed, by means of an acid, with earthy and watery particles. Nay, it is held in general, that every substance susceptible of a chemical operation, is a compound; and it is
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* Edinburgh Physical Essays, vol. 3. article 1.

natural to think so, for elementary particles are surely too minute for our handling. Now, as oil, far from being an element, is composed of various parts, it is certainly too gross for the mouths of plants. Its component parts may be sufficiently minute for admission: but these parts are not oil; though by an internal process they may be converted into oil, or converted into any other substance. Salt indeed is soluble in water, so as to become invisible; and with water consequently it may be imbibed by plants. But salt is too acrid to be a nourishment for plants; and if imbibed in any quantity, will be destructive.

I have given the strictest attention to this doctrine, in order to put the speculative farmer on his guard. If he assent to what is here delivered, it may save him much time, that would be lost in perusing certain husbandry-books, and much labour in prosecuting idle experiments. And here I must say again, for it cannot be too often said, that the province of agriculture, is to prepare the soil for yielding plenty of juices, leaving the rest to nature.

Tull is one of the boldest theorists that have come under my inspection. He pronounces without hesitation, that all plants live on the same food or *pabulum*, which he says is pulverized earth; and upon that foundation, he pretends to raise perpetual crops of wheat in the same field, by

by the plough alone, without manure. This indeed would restore the golden age of ease and indolence; as there is no soil so barren, but what may readily be pulverized. Tull was a man of genius, but miserably defective in principles. Plants imbibe water plentifully at the leaves, bark, and roots; and with water they imbibe whatever is dissolved in it. But earth is not soluble in water; and accordingly, by an experiment of Van Helmont it appears, that earth makes no part of the food of plants. He put into a vessel two hundred pounds of dry earth; which he moistened with rain-water, and planted in it a cutting of willow, weighing five pounds. The mouth of the vessel, to keep out dust, was covered with a tin-plate, having many small holes, through which rain or distilled water was poured from time to time, for keeping the earth moist. The willow weighed at the end of five years a hundred and sixty-nine pounds and about three ounces; and the weight would have been much greater, had the leaves that fell the first four years been computed. At the end of the fifth year, the earth was taken out of the vessel; and, when dried, was found to have lost none of the original weight excepting two ounces. Mr Boyle made a similar experiment with gourds, the result of which was the same *. Tull's system then is singularly unlucky:

* From experiments made by Dr Woodward, he affirms, that earth is imbibed with water in a considerable quantity

lucky : of all substances, earth appears to be the least fitted for nourishing plants ; and from Van Helmont's experiment it is clear, that if at all it enter the mouths of plants, the quantity is inconsiderable : of the great quantity of earth, two ounces only were lost ; and supposing these two ounces to have been dissolved in the water and sucked in by the plant, it was next to nothing, considering the weight of the whole plant, which was a hundred and sixty-nine pounds.

Other writers, more cautious, avoid specifying any particular substance as the food of plants : but hold, that every species requires a peculiar nourishment ; and that roots imbibe those juices only which are fitted for nourishing the plant. The refutation of this hypothesis will not require many words. It is sufficient to observe, that it is refuted by uncontestable experiments. Plants

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quantity (Transactions of the Royal Society, ann. 1699). In two glass phials full of water, he put an equal quantity of garden-mould. In one of them a plant of mint was set, and the earth after a time was sensibly diminished ; but not in the other where no plant was set. The doctor did not advert, that garden-mould, which perhaps for a century had been regularly dunged, must be replete with animal and vegetable particles that are soluble in water, and with it are imbibed by plants. By the extraction of such particles it is no wonder that the earth put into the phial was diminished. But such particles are not earth ; and therefore the Doctor's experiments contradict not those of Van Helmont and Mr Boyle.

take in with air and water whatever is dissolved in them, without distinguishing the salutary from the noxious : there is not the least appearance in any plant of a choice. Barley has been poisoned with brimstone, and mint with salt water. Mr George Bell student of physick in the college of Edinburgh, an ingenious young gentleman, made the following experiments, which he obligingly imparted to me. A number of Jerusalem artichokes were set in pots filled with pure sand. One plant was kept as a standard, being nourished with common water only. Other plants of the same kind, were nourished with water in which salt of tartar, a fixed alkali, was dissolved. These grew more vigorously than the standard plant. But by reiterated waterings, there came to be such an accumulation of the fixed alkali among the sand, as to make the plants decay, and at last to die. Some plants were nourished with water, in which sal ammoniac, a volatile alkali, was dissolved. These grew also well for some time ; but, like the former, were destroyed by the frequent reiteration of it. Weak lime-water promoted the growth of its plants more than common water. But water completely saturated with quick-lime, proved more noxious than that which contained a solution of fixed alkali ; though less than that which contained a solution of volatile alkali. Hence appears the hurt of overdosing a field with quick-lime. Urine promoted long
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the growth of plants; and the most putrid appeared to have the strongest effect: but at last, it totally destroyed them. Water impregnated with putrid animal and vegetable substances, did more effectually promote the growth of plants than any other solution; and in every stage of the progress appeared to be salutary.

Rotation of crops in the same field, universally practised, is what probably has promoted the opinion of a specific nourishment. It has been urged, that if all plants live on the same food, the soil must be exhausted by a succession of different plants, as much as by a succession of the same plant. This argument for a specific nourishment has a formidable appearance; and in order to obviate it, I found it necessary to give peculiar attention to that branch of husbandry, which is done above*. It is there made evident, that change of species is necessary, not for food, but for preventing degeneracy. It is not want of food that makes a horse degenerate in Britain; and as little want of food that makes wheat degenerate, where sown without intermission in the same field. Plants native to Britain never degenerate, though always growing in the same spot; white clover, for example, nettles, broom, whins, rushes, couch-grass, &c. &c. A bull-dog never degenerates in Britain.

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Animals

* Part 2. chap. I. § 3.

Animals from their food are divided into two kinds, carnivorous and graminivorous. But I discover no such distinction among plants : they imbibe indifferently whatever is dissolved in water. And the plan of nature appears to be what follows. Certain substances were originally provided for their food. It is highly probable, that a quantity was lodged on the surface of this earth, for nourishing the first plants : whence the fertility of virgin soils, such as have never been cultivated. This matter dissolved in water and imbibed by plants, is communicated to animals that feed on plants ; and is again set free by the death and putrefaction of these animals. The more volatile parts are attracted by the air : some are sucked in with air at the leaves of plants : some are washed down to the ground by rain ; and with it are sucked in at the roots. The less volatile parts, which the air does not attract, are dissolved in water, and with it are also sucked in. And thus the process is continued without end. This doctrine of a common nourishment, is firmly supported by the following facts. First, Plants of different kinds growing in the same spot, rob and starve each other ; which could not be, if each drew from the soil a separate nourishment. Second, Grafting and inoculating demonstrate a common nourishment. If the roots of the stock imbibe those juices only that are proper for its own nourishment, the grafted plant must starve.

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The juices imbibed by the former, nourish both; and these juices are by each plant converted first into sap, and then into its own substance. Third, Dung of putrefied vegetables, of whatever kind they be, is one homogeneous substance; and yet vegetable dung prepares the soil equally for every sort of plant. I add a consideration of a kind that to me is always persuasive: a common nourishment is not only a more simple, but a more wise dispensation of Providence than a peculiar food for each species: every plant grows not every where; and if each species required a peculiar food, a vast stock of vegetable food would remain unused; which is not conformable to the frugality of nature, nor to the wisdom of Providence, which makes nothing in vain.

But though all plants imbibe indifferently every substance that is dissolved in water; it follows not, that every such substance, even where innocent, is equally nourishing. Some substances may be proper nourishment, some not: and it may rationally be supposed, that the latter is thrown off as excrement. Why may there not be a resemblance in this particular, between plants and graminivorous animals? A horse, an ox, a sheep, a goat, live all of them on grass; but each of them have favourite grasses, which they prefer before other kinds. This will so far justify the notion of a specific nourishment. Let experiments be made, to try what is the most salutary food

food for plants. A few experiments of that kind are mentioned above ; but to give satisfaction, they ought to be multiplied and extended to plants of different kinds.

There is not an opinion more generally adopted, than the following concerning agriculture, whoever was the author, That fertility of soil depends on the quantity of nutritive matter in it, whether specific or common ; that when the quantity contained in any field is exhausted by cropping, it is restored by the plough, by dung, or by other manure ; and that to restore an exhausted field by such means, is the sole object of agriculture. This opinion has a fair appearance : nor did I ever entertain a doubt about it, till the following considerations happened to occur. I do not much relish the notion, that the number of plants growing at any time on this globe, must be limited by the quantity of matter created originally for their nourishment, nor that the quantity of graminivorous animals must be also so limited ; and yet this must necessarily follow, if plants have no other food but what was thus originally provided for them. But supposing this consideration not to weigh with others as with me, there are other considerations that cannot fail to make an impression. Some countries produce corn and cattle, not only for the inhabitants, but for exportation. According to the established opinion, these countries must long ago have

have been reduced to absolute barrenness. Egypt and Sicily were of old the granaries of Italy; and vast quantities of vegetable food, converted into corn, were annually exported from these countries never to return. Yet we do not find that they are less prolific than formerly. Sicily at present does not consume at home above the seventh part of its wheat; the remainder is exported; and yet not the least symptom of approaching barrenness. Consider the endless quantity of beef exported every year from Cork in Ireland: whatever quantity of vegetable food may originally have been stored up in that part of the island, it must long ago have been totally exhausted. I urge another objection more general. Where-ever burying under ground is the practice, the vegetable food contained in the bodies of human beings is totally lost, not to mention those who perish at sea. At that rate, there is a gradual diminution of vegetable food, so as that in time the whole must be exhausted. I add a fact to convince any thinking person, that plants must be provided with some food beside that originally created. In Scotland, there are fields that past memory have carried successive crops of wheat, pease, barley, oats, without a fallow, and without manure. And that there are such fields in England and elsewhere, it is not to be doubted. A field of nine or ten acres on the river Carron, is still more extraordinary. Up-
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on it I saw a good crop of oats almost ripe ; and by information it was the hundred and third crop of oats without intermission, and without manure, as far as was known. Now, whatever be the nature of such a soil, its unremitted fertility cannot be accounted for, from any supposed quantity of vegetable food originally accumulated in it. It is easy by manure to make a soil too rich for corn : it vegetates without end, and the seed has not, before winter, time to ripen. But supposing the richest soil to be proper for corn ; yet the vegetable food it contains, however great the quantity, must in time be exhausted by cropping. Some other provision therefore must be made by nature for the nourishment of plants, beside the vegetable food originally created.

Immense is the quantity of corn and straw, that during a century is produced in a soil perpetually fertile. It is a puzzling question, whence proceeds such a quantity of matter ; for a new creation cannot be admitted. A perpetual effect must have a perpetual cause : the soil must receive additions without end, to restore what is taken away in corn without end. I am aware, that the smallest portion of matter may by division be made to occupy space without bounds. But observe, that the difficulty arises from weight, not from bulk. Corn is a weighty substance ; and the corn produced on this globe from the beginning, must amount to a weight above computation :

putation : the small portion restored to the ground in manure, is a mere atom in comparison. I have endeavoured above to evince, that earth is not converted into corn : and here is an additional proof ; for such conversion would exhibit a very new scene : instead of the hills sinking down slowly into the vallies, the vallies would sink rapidly down from the hills. A perpetual effect, I have observed, must have a perpetual cause : to preserve a soil perpetually fertile, there must be a continual influx of vegetable food, to supply what is taken away by cropping. Whence comes that vegetable food ? where is it stored up ?

Air and water contribute to vegetation : let us try to build on that foundation. Supposing air and water to be the food of plants, not meaning to exclude what may be dissolved in them, the difficulty vanishes, as air and water are inexhaustible. And why may not that supposition hold in fact ? I begin with air. Many plants grow to perfection, without having any nourishment that can be discovered but air only. The house-leek grows from choice on a dry mud wall, which surely affords no nourishment. A species of the sedum, requiring a hot-house in winter, is never watered. The wall-flower grows luxuriantly in the seams between large square stones in old buildings, from which all moisture is excluded but what is in the air. Various kinds of moss
grow

grow upon hard stones, where they can have no nourishment but from the air. It is an universal opinion, that leguminous plants, before they seed, draw most of their nourishment from the air. Conformable to that opinion, Dr Hales, in his curious Statical Essays, has made it evident, that every vegetable contains a quantity of air, which adds to the weight as well as to the bulk. The fixed air in a green pea, makes no less than a third part of the weight. In wood, however old or dry, air is found, very observable when set loose by fire. Here is one inexhaustible store of matter for composing plants.

Water is another inexhaustible store. A plant regularly watered, will grow vigorously in the most barren soil, even in dead sand. In Persia, very little rain falls during summer, and the land is burnt up; not a pile of grass to be seen. But plants there regularly watered, grow excessively. There are many experiments of plants set in glasses upon moss or sponge, which grow well when watered. Some cotton was spread on water in a phial: a pea dropped on it sprung, and pushed roots through the cotton into the water. The plant grew vigorously, and bore large pods full of ripe seed. There is a noted experiment of an oak growing in pure water to the height of eighteen feet. Water is attracted by vegetables of every kind; and is sucked in at the roots, at the leaves, and even at the bark.

The

The quantity imbibed during a spring and a summer, is amazing. The quantity exhaled every day, is accurately measured in the Statical Effays mentioned; which must be less than what is imbibed, because plants do not throw off all they imbibe, part being converted into their substance, and adding to their bulk and weight*. The driest wood accordingly yields, by distillation, a large proportion of water. A stream occupies the lowest ground, without regard to soil; and yet the grass on its borders is always more rich and verdant than at a distance. A tree grows nowhere more vigorously than at the side of a brook. About a large stone fixed in the ground, the grass is generally the best in the field: for what other reason, than that the rain which falls on the stone runs off to the sides? I do not say, that the heat of the stone during summer may not contribute somewhat. The north side of a hill, is observed to be commonly better soil than the south side: if there be truth in the observation, it must proceed from moisture, less being evaporated from the former than from the latter. Black solid peat-

Y y moss

* The emission of water from plants, is the occasion that a country abounding with trees, is more subject to damps, humid air, and frequent rain, than a bare country where no trees grow. The excessive moisture of the American air was a great annoyance to our first settlers; but the air became more dry and the weather more constant, as the ground was cleared of trees.

moſs retains moiſture like a ſponge: trees grow vigorously in it, provided they be ſheltered from wind; for their roots cannot reſiſt wind in a ſoil ſo tender and looſe. On the other hand, no ſoil is more barren than a gravelly or ſandy moor that holds no water; upon which the foot makes no impreſſion, not even after a heavy ſhower. I am buſy at preſent in cultivating a moor of that kind, upon which are ſcattered ſome dwarfiſh plants of heath and bent, that leave half of the ſurface bare. I judged that manure would not anſwer, till the field ſhould be made to retain moiſture; for which reaſon I incorporated with it a quantity of ſoft ſpongy earth. I added lime and dung; and now it carries a rich crop of turnip and cabbage. The alteration of the ſoil is obvious to the eye; and alſo to feeling, as the foot dips in it after every ſhower. Lord Bacon long ago gave his opinion, that for nourishing vegetables, water is almoſt all in all; and that the earth ſerves but to keep the plant upright, and to preſerve it from too much heat or too much cold.

To ſupply the endless quantity of moiſture neceſſary for vegetation, nature has made ample proviſion. The continual circulation of water upon this globe, from its ſurface to the atmosphere, and down again to the ſurface, is juſtly admired for the ſimplicity of its cauſe, no leſs than for its bountiful effects. An elective attraction between air and water, is the *primum mobile* of theſe effects.

fects *. Water is eight hundred times heavier than air; and yet by that single power, an immense quantity of water is suspended in air; and falls down from time to time in rain, dew, and snow, impregnating the earth with moisture. Dr Hales, in a dry July, dug up a cubic foot of brick-earth, weighing one hundred and four pounds, which contained six pounds and eleven ounces of water. Under the former he dug up another cubic foot, weighing one hundred and six pounds and six ounces, which contained ten pounds of water. Under this he dug up a third cubic foot, weighing one hundred and eleven pounds and one third, which contained eight pounds and eight ounces of water. Here is a considerable stock of moisture, sufficient without rain to afford vegetable nourishment several weeks; not to mention what may be attracted from below, by the upper stratum when its moisture is exhausted. Evaporation goes on so rapidly between the tropics, that to preserve plants alive, moisture must be attracted from below: for, as mentioned in the first chapter of this part, there is an elective attraction between earth and water; and where a portion of earth is saturated with water, it readily yields its superfluous water to a dry body in contact with it. This ascent of moisture is promoted by the heat of the sun, which

* Edinburgh Physical Essays, vol. 3. art. 4.

which pierces deeper into the earth than two feet, according to experiments made by Dr Hales. Were not plants thus supplied with moisture in the torrid zone, where no rain falls for many months, they would be destroyed by the scorching heat of the sun. The evening dew that falls in a hot summer, is sucked up the following day, without ever sinking to the roots of plants.

But though air and water are made by nature the constant and inexhaustible food of plants, there seems to be little doubt but that this food may be enriched by various substances dissolved in them. We have seen above, that water impregnated with rotten animal and vegetable substances, makes rich nourishment for plants; and from experiments, other substances may probably be discovered, equally efficacious. Plain water may be sufficient for the stem, branches, and other gross parts; but we have reason to think, that richer nutritive matter is necessary for perfecting the seed. Hence the imperfection of seed in a rainy year, where the rich matter bears no proportion to the quantity of water that passes through a plant.

Moderate rain in a kindly season, warms tilled land, and produces a slight fermentation. It is here as in a dunghill: a very small quantity of moisture has scarce any effect: a great quantity chills the ground, instead of warming it. Different plants require different quantities of moisture.

Grass

Grass is benefited by all it receives ; provided the moisture exceed not so much, as to chill the ground and the roots of the plants *. So far corn resembles grass, as to be flunted by lack of moisture, and consequently to blanch early. The seed has more than time to ripen ; but it is lank and ill filled. Corn differs in being hurt by much moisture : it vegetates continually ; and winter comes on before the seed begins to ripen. Holland is a moist country : there is scarce a foot of dry ground in it. Trees, grass, and vegetables, grow there luxuriantly : but its fruits seldom ripen : and where ripe, have little taste.

Thus from air and water, with what they contain, there is an inexhaustible supply of vegetable nourishment, which fairly accounts for the immense quantity of corn that is annually produced.

If water be the chief food of plants, there never can be a large tree but adjacent to water running either above or under the surface. The experiments of Dr Hales make it appear, that plants perspire greatly ; and the perspiration of a large

* A grass plant cannot retain so much as to hurt it : whatever is imbibed more than sufficient for nourishment, perspires at the leaves. There is a considerable latitude in the quantity of healthy perspiration ; which, in the sun-flower, by an experiment of Dr Hales, appears to be from sixteen to twenty-eight ounces in twelve hours day. And he adds, that the more it was watered the more it perspired.

large spreading oak must be very great. Part of this perspiration must be supplied by a running stream ; for all the rain that falls within the circumference of a tree, is not sufficient.

The sun joins with air and water in nourishing plants. The green colour of plants is occasioned by an oily substance, which can be separated by a chemical operation ; and that oily substance is owing to the sun, for no plant is green where the sun is excluded. The sun therefore contributes to advance plants to perfection. And it is one of the properties of leguminous plants, that their broad leaves absorb more of the sun's rays, than the narrow leaves of culmiferous plants.

According to the foregoing theory, the only use of a soil, is to fix the roots of plants, and to hold water for nourishment. But at that rate, where lies the difference between a rich and a poor soil. This globe is surrounded with air, and rains pays not homage to one field in preference to another ? The solution of this question will, if I be not grossly mistaken, confirm the foregoing theory, and evince that it is founded on truth. Soils originally may have been very different with respect to fertility, supposing vegetable food to have been unequally distributed by the hand of nature. A virgin soil may be extremely rich ; witness the surprising fertility of America, when agriculture was introduced there. But cultivated grounds must long ago have been
deprived

deprived of that original food; in the course of cropping; after which, it does not enter into my conception, what other circumstance can remain to make a soil fertile, but the holding water in sufficient quantity for its plants. A clay soil holds a great quantity; a sandy soil, very little. Some soils there are singularly retentive of moisture; and that quality makes them long of drying: such soils are favourable to vegetation; for though they resist drought, they yield to the attraction of plants *. Other soils are very little retentive of moisture: they dry in an instant, and the nourishment they can afford is very scanty. Here the mystery is unfolded. The richest soil is what gives the greatest resistance to a drying air, and at the same time furnishes to its plants their proper quantity of moisture. I have a thorough conviction, that this property belongs to a soil perpetually fertile: and it is to me a strong confirmation of the present theory, that I cannot form even the slightest conception, how perpetual fertility can otherwise be accounted for; and as little can I form a conception, how otherwise countries, like Poland or Livonia, out of which great cargoes are annually exported of corn and flaxseed, should suffer no diminution of fertility.

To

* May it not be thought, that the quantity of moisture which gives to a soil its highest fermentation, is at the same time the fittest for perfecting seed. However pleasing this conjecture may be, I dare not vouch it for truth; it must be left to experiment.

To recruit with vegetable food a soil impoverished by cropping, has hitherto been held the only object of agriculture. But here opens a grander object, worthy to employ our keenest industry, that of making a soil perpetually fertile. Such soils actually exist: and why should it be thought, that imitation here is above the reach of art? Many are the instances of nature being imitated with success: let us not despair while any hope remains; for invention never was exerted upon a subject of greater utility. The attempt may suggest proper experiments: it may open new views; and if we fail in equalling nature, may we not however hope to approach it? A soil perpetually fertile, must be endowed with a power to retain moisture sufficient for its plants; and at the same time must be of a nature that does not harden by moisture. Calcareous earth promises to answer both ends: it prevents a soil from being hardened by water; and it may probably also invigorate its retentive faculty. A field that got a sufficient dose of clay-marl, carried above thirty successive rich crops, without either dung or fallow. Doth not a soil so meliorated draw near to one perpetually fertile? Near the east side of Fife, the coast for a mile inward is covered with sea sand, a foot deep or so; which is extremely fertile, by a mixture of sea shells, reduced to powder by attrition. The powdered shells, being the same with shell-marl, make the sand retentive of moisture; and

and yet no quantity of moisture will unite the sand into a solid body. A soil so mixed seems to be not far distant from one perpetually fertile. These, it is true, are at best but faint essays; but what will not perseverance accomplish in a good cause?

A soil is denominated fertile, that affords plenty of nourishment to its plants; and accordingly it is such a soil only that has been the subject of the foregoing investigation. Plants that live mostly on air, require not such a soil; witness the house-leek mentioned above. Juniper thrives on the top of a mountain, in the poorest and driest soil; because, in that situation, it is sufficiently supplied with moisture from the air. If planted in a dry climate, it requires a moist soil, to supply the want of a moist atmosphere. The nature of the yew is the same. Planted in a valley, it requires a damp soil. It will grow in the driest soil, as in the cleft of a rock, but then it must be at such a height, as to enjoy a humid air. These belong to the class of plants that affect to grow in a soil commonly reckoned barren. A soil that a mere farmer would pronounce barren, is for many plants excellent. How otherwise could the earth be every where cloathed with beauty? How great must be the diversity of soil, climate, and situation, that can raise to perfection above 20,000 kinds of plants, to each of which is requisite some peculiarity of soil, of climate, or of situation?

Z z

Whether

Whether the theory here exhibited will occasion any material alteration in the practice of agriculture, must be left to the discovery of time. Of one thing I am firmly convinced, that the instructions above delivered, are in every particular conformable to that theory. Take the following slight specimen. Plants, like animals, cannot live long in the same air: a circulation is to both equally requisite. For that reason, the growth of plants under cover, is slow; and seed springs slowly in stagnated air. Conformable to this observation, a free circulation of air for corn is warmly recommended; and there is a caveat against small inclosures surrounded with strips of planting, because they occasion a stagnation of air. Impure air imbibed, renders a plant unhealthy: the grain has a bad taste, and tends to generate diseases; which holds remarkably in a fruit-orchard, if the trees be crowded, and the walls high. Even grass, where the air stagnates, is unpalatable and unwholesome. Next, with respect to moisture. No branch of husbandry is more sedulously inculcated, than that of dividing and pulverizing earth by the plough, by the brake, by harrows, and by manure: it is the very life of agriculture. And from what is laid down above, it appears, that fertility depends greatly on that practice*: it increases the capacity of soil to contain water: it enlivens its retentive power; and it prevents the soil from hardening: to these ends

* Part 2. ch. 1. sect. 1.

ends manure greatly contributes; and in that view it makes the subject of the following chapter.

To aid the fertility of soil, the pickling seed has been much practised. We listen readily to the marvelous, especially where any great advantage is promised. The boasted effects of the Abbé de Valemont's prolific liquor, found many believers, by which vast crops were to be reaped, without manure, and almost without plowing. (See Du Hamel's treatise on the culture of land, vol. 6.) And the Baron de Haac's powder, is at present no less successful in England. The credulity of farmers might in some measure be excusable, were such bold pretensions within the verge of possibility. In every seed there is an embryo plant; and the rest of the seed serves to feed that plant, till it acquire roots for drawing its nourishment from the soil. The pulp is thus exhausted, and there remains only the useless husk. What advantage then can be derived from a prolific liquor or powder? It may possibly render the pulp fitter to feed the young plant, till it strike root. That it can have no other effect is evident; first, because it is exhausted with the seed; and, next, that supposing any of it to remain, it can be of no benefit to roots that are spread an inch, two, or three, from the place where the seed was laid. Yet books of agriculture are stuffed with such receipts.

I close this chapter with a reflection of the justly-esteemed Dr Hales. “ Though I am sensible, “ that from experience chiefly we are to expect “ the most certain rules of practice; yet the “ likeliest method for making the most judicious “ observations, and for improving any art, is to “ get the best insight we can into the nature and “ properties of what we are desirous to cultivate “ and improve.”

C H A P. III.

MEANS OF FERTILIZING SOILS.

AS these means are plowing and manuring, they shall be treated in their order.

I. PLOWING.

THERE are mutual connections between man and the ground he treads on, that fit them for each other. The dry part of this globe, is every where covered with a *stratum* of earth, producing vegetables for the nourishment of man and of other animals. Some *strata* there are, so barren as not to bear vegetables; and some vegetables there are, that afford no nourishment: but both are rare, and intended probably for other purposes.

This

This *stratum* is commonly sufficiently deep for a free course to the roots of plants : or it may be made so by art, it being one of the many purposes of agriculture to deepen a shallow soil. A deep soil beside giving free course to roots, retains much water to nourish them. In Scotland, partly from ignorance, partly from the weakness of labouring cattle, it is the general practice to plow with a shallow furrow, commonly under four inches ; and hitherto the progress toward a better mode has been slow. It is never difficult to invent reasons for justifying what we are accustomed to. " If we plow deep, we are afraid " of till." And what is till ? Where ground is stiff, rain settling at the bottom of the furrow cements the earth under it, which in time is hardened to a stone ; and it is this hardened earth which is named till. The earth is hardened as far as the water penetrates, which may be one or two inches ; but after till is formed, every drop of rain rests upon it without making any impression. To subdue till is an important object ; and luckily the undertaking is seldom difficult : a strong plough, raising it to the surface, lays it open to the sun, air, and frost, which restore it to its original state. One precaution is necessary. Certain earths, as hinted above, are averse to vegetation. These must be avoided, however shallow the soil be : but as such earths are rare, they

they ought not to be an excuse for shallow plowing.

The advantages of deep plowing, are manifold. In the first place, roots extend far where they meet no resistance; and the growth above the surface corresponds to that below: roots cramped in a shallow soil, are dwarfish; and consequently so is the tree. Dr Hales justly observes, that the greater proportion the surface of the roots bears to that of the tree, the greater is the vigour of the tree, and the better able to resist the attacks of an unkindly season.

In the next place, a deep soil affords not only space for roots, but holds a due proportion of water for nourishing the plant. If more rain fall than the soil can retain, it descends to the bottom of the furrow, where it lies lower than the roots, or but barely touches their extremities: the season must be very wet, that raises the water so high as to do much damage. The disadvantage of a shallow soil is in that respect very great. Roots accustomed to earth are unqualified to grow in water: they suffer when soaked in water; which must often happen in a shallow soil, and is visible above ground by a sickly yellow hue*. Upon that account, Miller enters a caveat against overwatering transplanted trees: "it rots the young fibres," says he, "as fast as they grow." Dr Hales

* Part 2. chap. 1. sect. 2.

Hales gives the same lesson. There is another disadvantage of a shallow soil: the water lodges so near the surface, as soon to be exhaled in dry weather. Thus, the excesses of moisture and of drought, are both of them incident to a shallow soil. In a deep soil, water lodged at the bottom of the furrow, is a reservoir, which is not exhausted but by long drought. Lastly, a deep soil affords space for placing the seed so, as that the roots may spread every way: in a shallow soil, if the seed be laid so deep as to be sufficiently covered, it approaches the hard bottom, unkindly to tender roots.

So much for a deep soil. I proceed to other advantages of plowing. Stiff soil is not penetrable by water: loose soil does not retain it. Plowing diminishes the tenacity of the former, and opens it to receive water: it makes the latter more compact, and increases its power of retaining water. Some earths fill not the hole out of which they were dug: some do more than fill it. Porosity occasions the former: the pores are diminished by handling, which makes it more compact. Solidity occasions the latter: clay swells by stirring; and continues so, till its former solidity be restored by the power of gravity*.

Another

* This experiment ought to be tried upon ground that has rested many years. Among the causes of porosity, one is, the great number of insects that have their dwelling

Another advantage of plowing regards clay chiefly, which by moisture turns hard if not duly stirred. This is an important article. Sand has no cohesion; and dry clay very little, if any *. It is water that cements clay; and in plowing makes it rise in lumps or clods, great or small in proportion to the degree of cohesion. Plowing prevents water from binding a clay-soil: the superfluous moisture is exhaled by frequent plowing, and no more left but to give the clay a degree of cohesion sufficient for fixing the roots. The nice point is, the time of applying the plough after much rain. To plow wet, kneads the parts together: on the other hand, the ground must not be suffered to turn hard. Between soft and hard is the proper condition for plowing; which may be known by the mouldering of the earth that is raised by the plough. During winter, clay may be stirred in a moister state, than during summer: frost prevents cohesion: heat promotes it. The management of light soil is very different. It is easily pulverized; but the difficulty

ling, under ground, and are expert miners. I speak not of moles and mice, whose subterranean walks and alleys are obvious to the eye; but of worms, beetles, ants, wasps, &c. whose works escape observation. Their excavations may in a long tract of time render the soil extremely porous. The fine earth they dig out, is left upon the surface, and blown away by the wind.

* Part 2. chap. 1. sect. 1.

ficulty is to preserve its moisture. A long drought, by extracting much of its moisture, renders it the less fit for vegetation; and to plow it in that state in dry weather, would render it entirely unfit. The only remedy is rain; and if drought set in, it ought to be rolled immediately after plowing.

The proper time of sowing and harrowing, is when there is no more moisture than sufficient to give the soil a proper consistence; and I conjecture, that the same degree of moisture is the fittest for making the seed spring. Reflect upon the making of malt: a certain degree of moisture is necessary for fermentation: too much checks it. Let rolling immediately follow, to prevent as much as possible any more evaporation. Where seed is to be sown in winter, or early in spring, it is right to plow sometime before, in order that the superfluous moisture may evaporate; for at that season there is no fear of exhausting the moisture. But late in the spring, if the season be dry, sow the seed immediately after plowing. The plants in their course of growing, return to the soil, during night, part of the moisture they draw from it during day. Their roots at the same time, spreading in every direction, keep the soil in constant motion, and prevent it from turning hard.

I close this section with an effect of plowing, the most important of all, because it holds in all

A a a

soils

soils less or more. Plowing keeps the soil loose for roots to take their natural course, and open for admitting air, dew, and rain. Dew in particular, which falls in plenty during summer, when most wanted, is lost upon hard soil, being exhaled by the next sun; but it sinks deep into loose soil, and is sheltered from the sun's power. Ground stirred before winter, is not only laid open to the action of the sun, wind, and frost, but is early ready for a spring crop, beans for example. It soon wets indeed, but it dries as soon. To drench in water ground left unstirred, may require a month or two; but then, equal time is required to dry it. The more earth is pulverized, the more water it holds*; and the more parts water is divided into, the more readily it is imbibed by plants. If the ground be rendered too loose, rolling not only makes it solid to secure the plants against wind, but also prevents evaporation.

How beneficial it is to keep soil open for the admission of nutritive matter, will appear from the following facts. Stiff soil gains little by rest; for as rain and dew get no admittance, they are soon carried off by evaporation. But soil, if tolerably open, improves by rest. I suspect that it gains little by the pasturing of cattle; for what they take away in fat with what they perspire, will nearly

* Part 2. chap. 1. sect. 1.

nearly balance the dung they leave : but it gains by the nutritive matter that rain and dew deposit in it : the rain may evaporate, but it leaves the nutritive matter. This case resembles salt deposited in the sea by rivers : water is evaporated from the sea, but the salt is left behind ; and hence the saltiness of the sea. The nutritive matter thus left in the earth, is again diluted in rain-water ; and though not attracted by the air, is attracted by plants, and enters into the orifices of the roots along with the water in which it is dissolved. There is another cause that has a share in the improvement of an open soil, and that is air, which, with its contents, enters by attraction into the bosom of an open soil *. The operation is indeed slow, because the attraction has no effect but in contact or near it ; yet in time, the quantity of nutritive matter attracted with air, may be considerable. Du Hamel reports, that the rubbish of a mud wall made good manure ; though the mud had been taken from a very poor soil. Grassy sod, used as a covering for cottages, turns good manure when it has lain long upon a house. The walls of a fold for sheep, being composed of sod, make good manure : when thrown down and mixed with the soil, they afford a better crop than the fold within, though enriched with the dung of the sheep. Among many

* Part 2. chap. 1. sect. 1.

many advantages of fallowing, the exposing to the air a new surface from time to time, is one ; by that means, every part of the soil draws air with the vegetable food it contains. Columella, book 2. chap. 4. advises ground to be reduced to dust by plowing. And he quotes a saying of the ancient Romans, That that land is ill plowed which wants harrowing after the seed is sown.

2. M A N U R E S.

THE operations of nature, hid from the ignorant and not always obvious to the learned, break out sometimes into broad day-light. Did animal bodies after death wither and dry without dissolving, this earth could not long have been a habitation for men : their utmost efforts would have been insufficient to remove dead carcases out of the way. Happily, putrefaction comes to their relief : dead bodies dissolve and mix with the soil, without leaving a trace behind. Putrefaction is a curious process of nature : air, moisture, heat, all of them, contribute ; but too much, or too little, is an impediment to the process.

On the surface of this globe, a process is continually going on, unregarded by the vulgar, being too familiar to draw their attention ; and yet, illustrious among the works of Providence for its beneficial effects. Plants and animals are generated,

rated, arrive at maturity; and after serving the purposes of nature, decay and rot. But the process ends not there. Loathsome putrid matter, from which we avert the eye, is made subservient to an excellent purpose, namely, renovation of plants; and the process goes on without end.

Manures are of two kinds. One attracts water and is attracted by it, dung for example, salt, calcined limestone, commonly called *quicklime*, or simply, *lime*. Another neither attracts water nor is attracted by it, shell-marl for example, clay-marl, stone-marl, raw limestone beat into powder.

Of all manures, dung is the most universal. A soil naturally stiff turns free and open, in proportion to the quantity of dung bestowed on it. Reduce clay into a dry powder: moisten it with water, and form it into a ball: repeat the operation at pleasure, it still returns to its original hardness. But moisten it once or twice with the juice of a dunghill, it becomes mellow, and never recovers its hardness. Dung therefore renders clay fertile, by opening it and giving admission to water. It does more: it makes every soil retentive of water. Examine a kitchen-garden that has been often dunged in the course of cropping: it will be found moist above any neighbouring ground of the same original soil.

As dung is composed of putrefied vegetables or of animal excrements, it is natural to think that it contains

contains more or less vegetable food. This however goes not beyond a conjecture : a plant or an animal may contain abundance of vegetable food ; but we are not certain that this is the case after putrefaction : it may by that process be converted into a different substance : such conversions in natural operations, are far from being rare. But if vegetable food be contained in dung, which is the most likely, another use of it is to deposit in the ground its vegetable food, which, being dissolved in water, is imbibed by plants, and converted into their substance. And from an experiment mentioned above it appears, that water impregnated with dung, is of all the greatest nourisher of plants.

A third use of dung is, to promote vegetation by raising a kindly heat in the ground. The sun-rays produce the same effect upon ground rendered black by culture ; for it is a property of all black bodies to attract and absorb rays of the sun*. Heat is best promoted by hot dung ; which therefore seems the most proper for corn. Whether hot dung be the best for making a soil retentive of moisture, remains to be ascertained by experiments. But I incline to think, that dung thoroughly putrefied, and consequently cool, is in its best condition for grass ; as it can be equally spread to give every plant its share. It is also

*Part 2. chap. 1. sect. 1.

also in its best condition for a kitchen-garden : green dung infects pot-herbs with an unfavourable taste, and sometimes with a disagreeable smell.

Let a dunghill remain years without stirring : it is reduced in appearance to fine earth ; which however has very little natural earth in it, as there is very little natural earth in vegetables, or in animals that feed on vegetables. Very few natural earths equal this vegetable earth in fertility : and it is a kind dispensation of Providence, not only that dung is a great fertilizer, but that when it becomes vegetable earth, it proves the best soil for vegetables. In corn-countries, the surface-earth comes in time to be mostly vegetable : were it inferior to natural earth, corn-countries would long ago have been rendered barren and unfit for agriculture.

From dung I proceed to other manures. Limestone, shell-marl, clay-marl, stone-marl, are all of them a composition of calcarious earth with other substances. Sand with calcarious earth makes limestone *. The shells of fish are almost entirely calcarious ; and these shells softened and reduced to powder in water, are called *shell-marl*. Clay-marl is a composition of calcarious earth and clay. Stone-marl is a composition of clay, sand, and calcarious earth : it is the sand that hardens it ;

* I have heard of limestone almost entirely calcarious, with little or no mixture of sand.

it; and according to the proportion of sand, it approaches to limestone or to clay-marl*.

It is observed above, that powdered clay is suspended in water, till by the superior force of gravity it fall to the bottom†. But, as far as I know, water has not the power of dissolving any sort of earth, calcined limestone alone excepted. A small quantity of calcined limestone, a pound for example, will impregnate a vast quantity of water, with no loss of bulk, and with a loss of weight scarce perceptible. Calcined limestone thus impregnated called *lime-water*, discovers itself to the taste though not to the eye. But this effect is confined to calcined limestone; for between water and calcarious earth in its natural state, there appears no elective attraction: water poured on shell-marl comes off pure, carrying nothing along with it. Nor do clay or stone-marl differ, even when reduced into powder.

Vegetation is more promoted by weak lime-water than by pure water. Two beans every way equal were set in pots filled with earth from the same heap: the one was moistened with lime-water, the other with pure water: the first was by far the quickest grower, and the most vigorous. Hence one benefit of quicklime: it converts

* See Dr Ainslie's accurate essay on marl. Edinburgh Essays physical and literary, vol. 3. art. 1.

† Part 2. chap. 1. sect. 1.

verts rain into lime-water, which is a great fertilizer. This effect however is but temporary, as will thus appear. Quicklime is limestone deprived of its air, by the force of fire: but quicklime exposed to the air, attracts air; and in time becomes again limestone as originally; consequently unfit to make lime-water*.

Quicklime may have an effect on land as well as on plants. It is highly probable, that it opens clay-soil to admit water that formerly rested on the surface. How otherwise can it be explained, that liming renders clay-soil drier? May it not also have the effect to increase the retentive power of a loose soil? This seems probable, if what Young the itinerant farmer says hold true, that lime has a much greater effect upon loose moor than upon any other soil.

Salt is powerful; and an overdoze of it does more mischief than of any other manure. It is soluble in water, and by that means enters the mouths of plants. Its effect then must be the same with that of lime-water; and considering how sparingly it ought to be laid on land, it is not obvious what other effect it can have.

As nothing can enter the mouths of plants but what is dissolved in air or water, calcarious earth in its natural state cannot enter. Yet shell-marl, clay-marl, stone-marl, composed mostly of calca-

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* Edinburgh Essays physical and literary, vol. 2. art. 8.

rious earth, contribute undoubtedly to fertility. If these manures cannot furnish nourishment to plants directly, they must produce that effect indirectly, by fitting a soil to retain moisture, or by preventing moisture from acting as a cement, or by both. They certainly have the effect to keep ground from hardening: they render clay loose and ductile, and prevent its being hardened by water. Whether they increase the power of any soil to retain water, is left to experiment.

An overdose of shell-marl, laid perhaps an inch thick, produces for a time large crops. But at last it renders the soil a *caput mortuum*, capable neither of corn nor grass; of which there are too many instances in Scotland: the same probably would follow, from an overdose of clay-marl, stone-marl, or pounded limestone. How is this to be accounted for? Of one thing we are certain, that by such overdose, light soil is rendered so loose as to be moved by the wind; and that even clay-soil is rendered so soft, as to receive the impression of the lightest foot at every step. Is it not then probable, that the soil is rendered so open, as to retain little or no water? But then, how comes the land to bear any crop at all? I am reduced to another conjecture, that ordinary plowing once a-year, is not sufficient to mix with the soil such a quantity of manure; and that an intimate mixture requires several years. Even a moderate dose of lime requires more than a year
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by such management for an intimate mixture; for which reason, the second crop after lime is always better than the first, and the third frequently better than the second. Now as the soil is opened by that part only which is mixed with it, the cropping may go on several years, before such a quantity of the overdose, is mixed as to occasion a total sterility. This conjecture may be brought under the touchstone of an experiment. Before or after harvest, let an overdose of shell-marl be intimately mixed with the soil by reiterated plowings and harrowings. If the barley sown next season fail by lack of moisture, the conjecture will be converted into a certainty.

Quicklime is of a nature very different from calcarious earth in its natural state: by the latter, land is rendered so loose by an overdose as to hold no water: by an overdose of the former, it is hardened to such a degree as to be impervious to water or to the roots of plants. Several spots in the Carle of Gowry, are thus rendered so hard as to be unfit for vegetation.

The quantity of calcarious earth in clay-marl, is frequently a half, and sometimes more. Five hundred cart-loads of clay-marl laid on an acre, are found not to be an over-dose. Supposing the half to be calcarious earth, and reckoning a cart to hold six bolls; here are fifteen hundred bolls of calcarious earth laid on an acre. Yet a far less quantity of shell-marl has been known to render
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the soil a *caput mortuum*; tho' there is not discovered any chemical difference, between the calcarious earth in clay-marl and that in shell-marl: they both equally are converted into lime by the force of fire. Ignorance of nature, betrays us at every turn to doubts and difficulties. May it not be conjectured, that calcarious earth, by entering into the composition of an animal body, becomes a more powerful manure than when mixed with earth? There is an argument from analogy to support that conjecture. Calcarious earth changes its nature by the action of fire; and why may it not suffer some change by being made part of an animal body?

Every particular in the present chapter, whether relative to the plough or to manure, is perfectly agreeable to the general proposition, That air and water with what is dissolved in them, make the nourishment of plants. To cultivate land in such a manner as to retain a proper quantity of air and water, is in all probability the chief or only means for making it fertile. In that view, I have all along warmly recommended pulverization; because the more a soil is pulverized, the more water it will hold, and the more retentive it will be of it. No mode of husbandry tends more to pulverization than horse-hoeing; nor any instruments more than the brake and the harrows above described. Soils are very different with respect to their power of attracting and retaining
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air and water. Let the diligent farmer make accurate experiments for ascertaining that difference, and for increasing that power : no inquiries tend more to the improvement of agriculture. Our attempts to make a soil perpetually fertile, will probably fail ; but our hopes of approaching it, may be crowned with success.

With respect to the contents of this Part in general, I have to observe, that in natural philosophy, of which the science of agriculture is a branch, questions occur of two kinds. First, Will a certain event happen in given circumstances ? Second, Supposing the event, what is the cause ? To questions of the first kind, the answer is *fiat experimentum*. All that can be done with respect to the other kind, is from a number of analogous facts, to form a general rule or law of nature. Such rules at the same time ought to be admitted with caution, even after the coolest induction. But those who are ardent for knowledge, cannot easily submit to the slow progress of philosophy : they are always in a hurry to draw conclusions, and hurry commonly leads them into error. Lord Bacon fancifully compares knowledge to a ladder. Upon the first step particular truths are discovered by observation or experiment. The next step is to collect these into more general truths ; from which the ascent is to what are still more general. There are many steps to be taken before we arrive

rive at the top ; that is, at the most general truths. But impatience makes us endeavour to leap at once from the lowest step to the highest : we tumble down, and find with regret that the work must begin anew.

To conclude. Here is my theory of agriculture, displayed at full length ; which is freely submitted to the public, against whose judgement there lies no appeal. But let it be kept in view, that it is submitted as probable only, not as certain. It would require the life of an antediluvian, to make all the experiments that are necessary, for piercing to the foundation, and for resolving all into clear principles. My life at any rate is too far advanced, for an undertaking so extensive. I found an impulse to expose this theory, naked as it is ; and I gave way to the impulse, because I flatter myself, that it may afford some light in tracing the operations of nature. One advantage it has above several other theories, that it can be subjected to the touchstone of experiments, many of which are suggested above. By such experiments, sagaciously conducted, it must stand or fall.

AP.

A P P E N D I X.

ARTICLE I.

IMPERFECTION OF SCOTCH HUSBANDRY.

A Man can never have thorough confidence in his road, till he be made acquainted with the by-paths that mislead him; and to be made acquainted with the errors of our neighbours, is the high way to good husbandry. My present purpose, is to delineate the imperfect state of Scotch husbandry, not only as formerly practised every where, but as practised at present in most places. To contemplate the low state of their country in the most important of all arts, cannot fail to excite ambition to excel in the few who are skilful, and to rouse imitation in others.

Our crops in general are very indifferent; and how can it be otherwise, considering our instruments of husbandry, which are sadly imperfect? What can be expected from them in a poor soil, when they perform so little even in the richest? Our crops accordingly correspond to our instruments.

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From many examples it is made evident, that our soil and climate are capable of producing draught-horses, patient of labour, and singularly hardy. Yet the breed is so much neglected, that they are commonly miserable creatures, without strength or mettle. Did landlords attend to their interest, they would be diligent to improve the breed. Why do they not reflect, that the same farm-servants with better horses, would double the ordinary work? By improving the breed, they would draw more rent from their tenants, without lying any additional burden upon them. With respect to oxen, there is no care taken either in the breeding or feeding. How easy is it for a gentleman to procure a good bull for his tenants? and from the little care of providing food for draught-oxen, one would suspect it to be a general opinion, that they require no food. In summer they are turned out into bare pasture, scarce sufficient for sheep. In winter, a small bottle of straw, not above a stone weight, is all that is allowed them in the twenty-four hours; which after the turn of the year, being dry and sapless, affords very little nourishment. What can animals so fed do in a plough? And yet such is the stupidity of many farmers, that instead of adding to the food, they add to the number; as if it would mend the matter, to add cattle that can scarce support their own weight. One unaccustomed to see ten oxen in a plough led on by two horses,

horses, cannot avoid smiling. With his goad the driver beats the horses, and pricks every ox as he advances. He then runs forward twenty yards to beat the horses a second time and prick the oxen. Some of the oxen in the mean time, instead of drawing, are found hanging on the yoke, and keeping others back. It is indeed next to impracticable, to make ten weak oxen in a plough, draw all at the same time. Nor is this the only inconvenience. A great number of oxen by such management, are requisite for stocking a farm; the expence of which is not always within the reach of the most industrious. In a year of scarcity beside, the beasts are actually starved. And what is worst of all, the tenant, in order to get straw for his cattle, is commonly necessitated to thresh out his corn, without waiting for a market, or having a granery for it.

Our farmers, led entirely by custom, not by reflection, seldom think of proportioning the number of their working cattle, to the uses they have for them. Hence, in different counties, from six to twelve oxen in a plough, without any regard to the soil. Seldom it is, that more than four good beasts can be necessary, if the proper time for plowing be watched.

The division of a farm into infield and outfield, is execrable husbandry. Formerly, war employed the bulk of our people: the remainder were far from sufficiently numerous for cultivating even

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that small proportion of our land which is capable of the plough. Hence extensive farms, a small part of which next the dwelling, termed *in-field*, was cultivated for corn: the remainder, termed *outfield*, was abandoned to the cattle, in appearance for pasture, but in reality for starving. The same mode continues to this day, without many exceptions, though necessity cannot be pleaded for it. But custom is the ruling principle that governs all. Sad is the condition of the labouring cattle; which are often reduced to thistles, and withered straw. A single acre of red clover would give more food than a whole outfield; yet how common is the complaint of tenants, that they are disabled from carrying on any summer-work, for want of food to their horses; a shameful complaint, considering how easy the remedy is.

Custom is no where more prevalent than in the form of ridges. No less high than broad, they are enormous masses of accumulated earth, that admit not cross-plowing, nor any plowing but gathering and cleaving. Custom and imitation are so powerful, as that our ridges are no less high in the steepest bank, than in the flattest field. Balks between ridges are equally frequent, though invincible obstructions to good culture. It would puzzle one at first view to explain, why such strips of land are left untilld. They must have been reserved originally, as a receptacle for stones, thrown

thrown off the tilled land ; and husbandmen were led by imitation to leave such strips, even where there were few or no stones.

The proper time for plowing or harrowing, is when the soil upon stirring moulders into small parts. This is not observed by farmers so carefully as it ought to be. How common is it to see even a clay soil plowed, when soaked in water, or when hard like a stone. Little attention is given to what may be termed *the frost-preparation* ; which is, to open the ground before winter, in order that frost may pierce deep, and mellow the soil.

Shallow plowing is universal, without the least regard to deepness of soil. The temperance of our people may be a proper subject for ironical praise ; for though nature affords commonly ten or twelve inches of soil, they are humbly satisfied with a half or third.

Ribbing is a general practice, though the slightest reflection is sufficient to make it evident, that to leave half of the land untilled, must be wretched husbandry.

Summer-fallow has of late years crept in, and is now common in three or four counties. In the rest of Scotland, for want of summer-fallow, there is a continual struggle for superiority, between corn and weeds. Do not such provoking farmers see, that it is fruitless to manure land over-run with weeds ? Do they not observe, that
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the manure they bestow encourages weeds as much as corn; or rather, that it enervates the weeds to destroy the corn? Make a progress through Scotland, you see stubborn weeds in every corner scattering their seed, and fouling the ground more and more. It is an easy work to cut down weeds before they go to seed. Would not one think, that work so easy would never be neglected? and yet it is never done. A Scotch farmer behaves worse than Esau: the latter got a mess of pottage for his birthright; the former surrenders his to weeds, without any recompense.

There is scarce such a thing practised, as to harrow before sowing. The seed is thrown into rough uneven ground, and the half is buried.

The roller is a most useful instrument. It was unknown till lately; and even at present is very little used.

With regard to rotation of crops, a most important article, there is great ignorance among our farmers. As it would be tedious to enter into particulars, I refer to ch. 7. where that subject is treated of.

Our farmers show very little skill in harvest-work. I confine myself to a single instance. The sheaves are bound up with a rope, composed of two lengths of the corn, twisted together; which makes the sheaves commonly of a monstrous size. The binder, pressing hard with his knee, binds the
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the sheaf so close, as with difficulty to admit his finger. The weather must be extremely favourable, if it be sufficiently dry in a fortnight, to be ventured in a stack ; it commonly must stand in the field three weeks. Let any one consider the risk of the crop in various weather, such as happens ordinarily in autumn. Nor is this all. Such sheaves are not only unhandy, but are apt to loosen in being carried to the stack, or from the stack to the barn. A sheaf should never exceed what can be slightly bound together with a single length of the corn : it is fitter to be stacked in a week, than ordinary sheaves in three.

No branch of husbandry is less understood, than manure. A dunghill is a very improper bed for corn : lime and marl are still more improper ; for nothing will grow on them. Hence it is apparent, that the intimate mixture of manure with the soil, is the great circumstance for vegetation. In order to that end, the soil ought to be highly pulverized, and the manure divided into its smallest parts. With respect to dung in particular, it ought to be carefully mixed in the dunghill, not neglecting to divide by the hand any lumps that may be in it. Let our farmers say, whether they are so accurate. Nothing more ordinary, than heaps of dung withering in the field, incapable to be intimately mixed with any soil. Nothing more ordinary, than dung laid on the dunghill in
barrowfuls,

barrowfuls, without being spread or mixed with what was there before.

A potato is a most useful plant, and, when properly cultivated, affords a plentiful crop. It is a great resource to the labouring poor, being a nourishing food that requires very little cooking. We have been afflicted of late years with very bad seasons, which, but for that resource, must have driven many of our people from their native country. Yet potatoes to this day continue to be propagated in lazy-beds. Expert farmers, not many in number, raise them with the plough at the twentieth part of the expence. This method has beside two other advantages: it leaves the soil in the best state for subsequent crops; and the potatoes are more palatable than what are raised in a lazy-bed.

Swine make a profitable article of husbandry, very little attended to in Scotland. They are fed at a small expence, and yet make most nourishing food. Every person who has a cow, ought also to have a pig. This is universal in England: it is creeping into Berwickshire, but in few other places as far as I know.

Very few farms in Scotland are justly proportioned: some are too small; the bulk of them too large. The former lead to a habit of idleness; the latter into a habit of slovenliness, by want of power to do justice to every part. There is not an article in husbandry more essential, than

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to adjust a farm to the skill and ability of the tenant.

ARTICLE II.

A BOARD FOR IMPROVING AGRICULTURE.

IT is a maxim in politics, that every country will be populous in proportion to the fertility of its soil; upon which account, agriculture is the most useful of all arts. And yet it is a sad truth, that in Scotland, this art has advanced not far beyond the first stage of its progress. In England indeed, it has made a much greater advance; and yet far inferior in perfection to English manufactures and commerce. Agriculture is carried on every where without a school; and for that reason, is commonly thought to require no schooling. Can a British minister embrace any measure more patriotic, than to encourage agriculture and its professors? No other measure would so effectually aggrandize Britain. A small share of the money and attention bestowed on raising colonies in America, would have done wonders at home. And yet, mark the striking difference: our arts are our own, which we never can be deprived of while industry remains: in the very constitution of our colonies, on the contrary, there are causes of separation, that grow daily

daily more and more efficacious; a wide-extended country, a fertile soil, navigable rivers, and a growing population. I disregard the present rebellion of our Americans: for they will soon be reduced to obedience. But as they derive from Britain high notions of liberty and independence, and as they are daily encreasing in power and opulence, the æra of their total separation, cannot be at a great distance. It is indeed absurd to think, that a great nation, in the vigour of prosperity and patriotism, can be kept in subjection by a nation not more powerful, enervated by luxury and avarice. Let us not however dispond; for if agriculture be carried on but to the perfection that our soil and climate readily admit, it will amply compensate the loss of these colonies.

Books are useful for advancing husbandry, otherwise this little treatise should not have seen the light. But books are far inferior to living instructors, who convey knowledge by practice as well as precept. We have a board for manufactures and fisheries; a wise institution which has been attended with great success. Why not also a board for agriculture? Is agriculture a less useful art than these mentioned? or does it less require instruction? Hartlib, in his legacy, laments that no public director of husbandry had ever been established in England. The present time is in Scotland the happiest for such an establishment.

Before

Before the union of the two kingdoms, our people were so benumbed with oppression, that the most able director would have made no impression. Freedom has braced their nerves, and has made them take heart to be industrious. They listen to instruction: let them perceive their interest, and they will cheerfully practise what they are taught. A board for agriculture would among us have wonderful success in many important articles. Considering the quantity of waste land even in our best-cultivated counties, it is not too sanguine to hope, that our corn-crops may be doubled. What a blessing would this be to Scotland, which for many years has been reduced to import great quantities? Our horses and horned cattle, are far inferior to what may be produced by good management. Our sheep weigh not above ten pounds a quarter, nor their wool above two pounds. The soil by good culture would feed sheep to the weight of twenty-four pounds a quarter; carrying from six to ten pounds of wool, a valuable acquisition to the woollen manufacture. Lambs in several instances have been advanced to twelve shillings a-head, and wedders to forty shillings. These are but a specimen of the various improvements that might be perfected by such a board.

The plan I have in view, is simple. Let the board consist of nine members, the most noted for skill in husbandry, and for patriotism. As I

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propose no reward to these gentlemen but the honour of serving their country, the choice will not be difficult : in lucrative employments, personal connections have more influence than personal merit ; and it is avarice only that sets people at variance. Where personal merit is the sole object of choice, there is seldom much difference in opinion. And to have a right set of members at first is of the utmost importance. If deficient in knowledge, they will have no influence, and perhaps be sneered at. But let men be chosen who have the public voice for them : they will have great authority, and every direction of theirs will be obeyed. To ease the board in the laborious branch of their business, they ought to be provided with an able secretary, to minute their proceedings, to write their dispatches, and to carry on their correspondence, foreign and domestic. As punctual attendance is necessary, the good behaviour of such an officer may well intitle him to a salary of L. 100 yearly ; with the addition of L. 30 more in a year of extraordinary business, at the discretion of the board ; but not unless all the members be unanimous. A larger salary would be an object of interest, and soon degenerate into a sinecure.

A regular meeting once a month may be sufficient ; with liberty to those who have most leisure, to meet at intervals for expediting what may require dispatch. It would cramp the proceedings

ceedings of such a board, to confine it to a quorum. As there cannot be any self-interest to create a bias, those who meet ought to have the power of the whole ; and what they transact ought to be final, if not altered by a greater number the next monthly meeting.

The things necessary to be undertaken by this board at the commencement of their operations, will require much labour and sagacity. The first is, to make out a state of the husbandry practised in the different counties ; in which notice must be taken of the climate, of the soil, of the mode of cropping, and of the instruments of husbandry, noting the prices of all the particulars that enter into farming. The next is written instructions for improving husbandry, suited to the soil and situation of every district ; with special reference to the present practice, showing where it is defective or erroneous, and proposing the cheapest and most effectual corrections. These preliminaries being settled, the ordinary business of the board, may be carried on easily and commodiously. In the first place, there is a necessity for an inspector, named by the board, to make a progress from time to time in successive places, for reporting the progress of the improvements directed, and for giving instruction in cases that cannot so clearly be put in writing. In this progress, special notice ought to be taken of the best-conducted farms, whether by landlords or tenants.

A few silver medals bestowed on the most deserving, will rouse emulation in all, and promote industry. Second, this board will consider it as a capital branch of business, to answer queries, and to solicit a correspondence with men of skill. Third, they ought carefully to inform themselves of every invention that tends to improve the art, and to publish what they think useful. Fourth, premiums ought to be proposed, and distributed among those who profit the most by the instructions of the board. These premiums ought to be ploughs, harrows, carts, constructed after the best models; which beside exciting industry, will be a means to introduce the best husbandry-instruments. Fifth, in no other respect would a board of agriculture be so useful, as in directing proper experiments. Agriculture, though the prime of arts, is far from perfection in any country. This in part is owing to its complex nature; but chiefly, to the length of time that is necessary to ascertain, by a course of experiments, any capital point in theory or practice. The life of man is too short for such an undertaking. The only remedy is to employ many hands upon different experiments; which cannot be done effectually, but under the direction of a board that never dies. Let lists be made from time to time, of the points that are capable to be ascertained by experiments: let proper experiments be suggested: let these experiments be distributed

distributed among persons of skill. And when their success is reported, the conclusions that may be drawn from them, ought to be published. This would be the most effectual method that ever has been contrived, to ripen knowledge in husbandry. To enliven this branch of business, premiums ought to be proposed, lucrative as well as honorary.

Of the premiums to be distributed, scarce any would be of more general benefit than to the best hand-hoers under the age of fifteen. Boys in driving the cart or the plough find exercise for their limbs; but in husbandry the arms are seldom exercised till they be full grown. I relish hand-hoeing for keeping ground clean: I relish it more for the opportunity it gives to exercise the arms of young creatures, male and female, from ten upward: give them only hoes of different sizes adapted to their strength. I venture to affirm, that the strength of a man's arms who has been employ'd in hand-hoeing from his tender years will be far greater, perhaps a third, than if they had never been exercised till he was fully grown. This would be a great advantage in several employments, civil and military, as well as in agriculture. Add another advantage. People accustomed from their tender years to keep ground clean, will contract an early aversion to weeds, and declare perpetual war against them. My labourers have good kitchen gardens,
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where onions, leeks, cabbage, turnip, and potatoes are sown in drills. The hoe is constantly employed by their wives or their children. You may see a dirty face among them, but not a dirty garden.

To make the board proceed with spirit, a book or pamphlet ought to be published annually, containing their transactions during the preceding year. The profit of the work, is a perquisite to the secretary; which will encourage him to bestow his utmost skill in the compilation.

To procure public favour, men of character and knowledge may be introduced by the members at their monthly meetings, to assist in their deliberations.

The choice of proper members, is the capital point: the whole depends on it. The choice is the more difficult, as it must be confined to gentlemen who reside in Edinburgh, some part of the year; because from others punctual attendance cannot be expected. It would be unsafe to leave the choice to members of parliament; who even against their private sentiments, are obliged to solicit for their friends and voters, without regard to merit. The choice must not be left absolutely to the chief minister: who, at such a distance, is seldom personally acquainted with the best qualified. The safest method I can think of is, that the justices of peace of each corn-county, should at a quarter-sessions name one. Out of these,

these, the nine members are chosen by the crown.

In Scotland, many noblemen and gentlemen, skilful in husbandry and zealous to promote it, would make excellent members but for their distance from the capital. To require constant attendance from such would be too great a burden; but to intitle them to act when they should find it convenient, under the title of honorary members, would add great lustre to the board.

The choice of a member to supply a vacancy, is a matter no less delicate. A society of gentlemen, who serve for honour not for profit, are well intitled to choose their companion. But to avoid faction, which would be ruinous in such a society, the choice ought to be unanimous. The dissent of a single member need not be regarded; but if two dissent, the choice must be in the crown. If a member be absent three successive monthly meetings, without an excuse approved by the board, he is to be held as having deserted his office, to make way for the election of a new member.

The election of a secretary is a point still more delicate. The board ought naturally to have the choice of their own secretary; but in case of a division, the dissent of three from the other six, shall transfer the election to the crown.

The royal society in London, is perhaps the only society in the world, that has flourished so long,
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with no other motive but thirst for knowledge. The members have now an additional motive, which is the reputation of being enlisted in a society, so illustrious. In the present low state of patriotism, affection to one's country is not alone sufficient, to preserve long in vigour a board of agriculture. Luckily, there is an additional motive, inherent in the very nature of the institution. Money is necessary to carry on the operations of the society; and the distribution of that money among persons of merit, will be a constant entertainment to the members. A great sum would be a temptation to misapply it. Therefore, no more ought to be put in their power, but what is barely sufficient to carry on the management with success. Beside the secretary's salary, L. 500 yearly discreetly distributed may be sufficient. And I boldly affirm, that such a sum cannot be laid out with more advantage, whether the public be regarded, or the good of a valuable portion of our people.

The house possessed by the trustees for manufactures, will afford good accommodation to both societies; and several of the acting trustees are qualified to make a figure in both.

Zeal for the prosperity of Britain, makes me ardently wish to have this plan extended to England. The English enjoy the reputation of being excellent farmers; and so they are, compared with their neighbours in France, Italy, and Spain.

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They are however far, very far, from the perfection of the art. A board for agriculture is indeed less necessary in England, than in Scotland; but that England would be greatly profited by such an institution, will be acknowledged by every one who is acquainted with English agriculture. I appeal to Mr Young for the following facts, extracted from his different tours; which, at the same time, are but a specimen of much wrong practice mentioned by him.

Seldom is a plough seen in England with fewer than four horses, nor is it always confined to that number; and yet, seldom are more than two horses necessary, if the plough be well constructed. A great sum is thus expended upon superfluous horses, which wounds the public by unnecessary consumption, is hurtful to landlords by lessening their rent, and retards the progress of husbandry. Among numberless instances, I mention the Isle of Thanet, where the soil is a light loam on a chalky bottom; and yet with four horses in each plough, they seldom pierce deeper than three inches, which is scratching instead of plowing. In Litchesterhire the common practice is to use from four to seven horses in a plough, even where the soil is a sandy loam. With this plough they seldom do more than half an acre in a day; and yet there are gentlemen there who with two horses plough with ease a whole acre.

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The number of draught cattle is seldom proportioned, with any accuracy, to the extent of the farm. Frequently, no fewer than eight horses and as many oxen, are employed in a farm of a hundred acres. With such an expence, the land must be fertile indeed, if it afford any rent to the landlord. In some farms not exceeding fifty acres, six horses are kept. The using oxen instead of horses, and employing no more of them than necessary, would be a saving to England of several millions yearly. Were that improvement accompanied with a proper regulation for the poor, England would be in a higher state of prosperity, than is enjoyed by any other nation.

A skilful rotation of crops, is far from being common. Instances are frequent in every part of England of the following rotations, fallow, wheat, oats, wheat. Also, fallow, wheat, oats, oats. Also, fallow, wheat, oats, barley. Also, barley, oats, oats. Also, turnip, barley, oats, oats. Even the best soils must be exhausted in time, by such oppressive cropping.

The great advantages of horse-hoeing, are a crop, and at the same time a substantial fallow. And yet, horse-hoeing, though invented in England, is not practised there. Many farmers do not even hand-hoe their turnip crop; and many neglect to hand-hoe their bean-crop, after being sowed in drills.

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The proper management of artificial grasses, is far from being common. Of all grasses, red clover is the most beneficial; and yet there are farmers, not a few in number, who banish red clover, as hurtful by fostering weeds. It has indeed that effect, if allowed to grow three or four years; but why not change it every year? It is not unfrequent to see a field left to be covered with natural grass. By this slovenly practice, the crops are not only scanty, but of a bad kind. In Derbyshire particularly, a field, after three successive crops of oats, is abandoned to nature. Worse husbandry is not to be met with, among the most ignorant farmers in Scotland.

Draining indeed is common, but conducted with little skill. There is no such thing known in England as drains on the surface made with the plough; though such drains possess the advantages of being cheap, effectual, and perpetual.

Let me add to these the following of my own observation. Travelling from Burrowbridge to Ferrybridge, Doncaster, Worsop, Mansfield, Nottingham, &c. the land is mostly of a sandy soil. The far greater part is laid out in grass enclosures, which give no proper return as the grass soon withers in summer. It ought to be cropped with turnip, potatoes, barley, hay, and plenty of red clover for summer feeding. Such cropping would afford four times its present rent, beside promoting population and the public revenue. But without

out a board of agriculture this reform cannot be made. A board of agriculture would select a few of the most promising tenants to execute their improving plans, and join with the landlords in premiums to the most deserving. Success and prosperity would prevail with others to follow their example. From Birmingham to Liverpool thro' Wolverhampton, Stafford, &c. mostly a sandy soil, yet no turnip and little red clover. The making hay is not generally well conducted in England. In the year 1778, the weather was both dry and hot during the time of this operation; and yet I frequently saw the hay spread on the ground lying withering whole days together. In the county of Chester, cheese is the chief product; and yet appears not to be managed to the greatest advantage. The grass enclosures are far from being rich. It is said indeed that rich grass would make the curd ferment and swell, which would occasion the cheese to be full of holes. However this be, I am certain that an acre of red clover would feed more than six of their grass acres; and if the cheese produced be richer, it may not indeed be Cheshire cheese, but it will give a better price. In a dry summer beside, their pasture grounds become early bare; and they supply the want of grass with hay. Would not green clover be a comfortable resource in such a case? But what I chiefly insist on as unexcusable, is that their cows are a heavy burden on them all winter, being

ing fed with hay and at times with sheaves of unthreshed corn. The soil is every where well adapted for turnip; which during winter would produce milk, sufficient in butter to pay the expence of the turnip; beside preserving the cows in good plight for calving. It would be easy for a board of agriculture to set on foot this improvement; and as the present practice is of a long standing, it will never be thought of otherwise.

From the beginning of time every substantial improvement has been set on foot by the landlord, who has the capital interest. The management of estates in England is generally not in the hands of the proprietor, but of his steward, whose advantage it is to squeeze the tenants for his own profit, and not to improve the land for that of his master. It is his interest to keep the tenants low and at his mercy; for an opulent tenant might stand in opposition and proclaim dangerous truths. When this is the case, is it a wonder to see much bad husbandry in England?

The foregoing errors and imperfections, with an endless number more, would be remedied by a board, eminent for patriotism and for skill in agriculture; and farmers would fairly be directed to the road that leads to the perfection of their art. Population and industry would be the consequences, with a great increase in the public revenue. England would become so prosperous and powerful, as to suffer little distress from

from the loss of its American colonies, should that ungrateful people succeed ultimately in a total defection.

ARTICLE III.

GENERAL HEADS OF A LEASE FOR A CORN-FARM.

IN a lease of this kind, what chiefly ought to be in view, is to restrain the tenant from impoverishing the land, and yet leave him at liberty to improve it; resembling a British monarch, who has unbounded power to do good, none to do mischief. In this variable climate, the tenant must not be tied down to invariable rules of cropping: an unusual season, hot, cold, dry, or wet, will necessitate him, for a year at least, to abandon the best plan of cropping that can be contrived before hand.

This observation is not intended to banish rules altogether. Some tenants, like some kings, may be trusted with unlimited powers. But such powers would be no less destructive to the generality of tenants themselves, than to their landlords. Tenants, therefore, like kings, must be fettered; but in what manner, is a question no less difficult than useful. They ought not to be

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so fettered as to bar improvements ; nor left at liberty to do mischief.

Before entering into particulars, it must be observed, that different situations with regard to manure, soil, and climate, require different modes of husbandry. All that can be done in an attempt like the present, is to suggest a few general rules, for a landlord to chuse upon in granting leases. It is his business to judge which of these rules will best fit his situation.

The first respects the time of endurance, which, though an important article, is unnecessary to be enlarged on here. It is believed to be now the universal opinion, that without a long lease, it is vain to hope for an improving tenant. The most approved time of endurance, as the likeliest to prevent waste, is to fix a time certain, suppose nineteen or two nineteen years ; and to add the life of the tenant who is in possession at the expiry of the time certain. A man never loses hope of living longer ; and he will never run out ground, that he hopes yet to be long in possession of. By this means, the tenant is deluded into a course of management, equally profitable to himself and to his landlord. But what, if, after liming or other expensive manure, the tenant happen to die suddenly before reaping any profit ? With a view to that event, let there be a clause in the lease, for paying to his representatives

tives what sum the tenant's profit has fallen short of the expence.

Second, Assignees and subtenants ought to be excluded. For where a tenant has it in his power to make his lease a subject of commerce, he will be sparing in laying out money on improvements.

Third, Whether the rent ought to be paid in corn or money, depends on circumstances. Corn-rent cramps the tenant in his management; for it obliges him to sow yearly corn of the same kind with what he pays. Money-rent, on the contrary, promotes good culture, in order to produce the weightiest grain, the benefit of which accrues entirely to the tenant. There is an additional reason for money-rent, that the tenant, by prudence and patience, can draw a better price for his corns at the home-market, than his landlord can. The rent therefore ought to be paid in money, unless where there is a superfluity of corn for exportation; which can be managed with more advantage by the landlord, who has all his farm-corns to export, than by the tenant who has but a small quantity.

Fourth, In this country, the profit of grass is to this day not understood, but by a few. Corn is the object of the generality; and that wrong bias ought to be rectified, by a clause confining the tenant to a certain proportion of his land in corn, a third, for example, or a half. There cannot

cannot be a general rule ; because it varies with the nature of the soil, and still more with the opportunity of manure. But to give room for extraordinary improvements, an addition to the proportion of corn may be indulged, upon condition of paying shillings additional rent for every acre above the proportion originally agreed on.

Fifth, A clause prohibiting white corn-crops to be taken in immediate succession, will be an effectual bar against impoverishing the land. Pease, beans, turnip, cabbage, and potatoes are profitable crops ; and red clover may be more profitable than any of them, by feeding all the farm-cattle upon it, which will save many acres of pasture. This and the foregoing rule, without any other precaution, will in all events suffice to keep the ground in good heart.

Sixth, The following, or some such clause, will excite a tenant's highest industry to improve his farm, supposing it to be only for nineteen years. At expiry of the lease, the tenant shall be intitled to a second nineteen years, upon paying a fifth part more of rent ; unless the landlord give him ten years purchase of that fifth part. The rent, for example, is L. 100. The tenant offers L. 120. He is intitled to continue his possession a second nineteen years at the advanced rent, unless the landlord pay him L. 200. If he offer a still higher rent, the landlord cannot turn him out, unless he pay him ten years purchase of that offer.

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Seventh, As both landlord and tenant are concerned in preserving the fences, both ought to concur in the expence. Therefore, let the care of the fences be trusted to the landlord's hedger; and whatever work is bestowed on the tenant's fences, shall be paid to the hedger at so much *per* day. Where the preservation of the fences is left entirely to the tenant he turns careless and does things by halves; where it is left entirely to the landlord, the tenant takes no care to keep his cattle from trespassing.

Eighth, In order to preserve to the landlord a privilege to plant trees, which is commonly neglected in leases, I propose that out of the lease be excepted certain spots, proper to be planted, for shelter, for beauty, or as not being arable; the landlord to enclose and plant, the tenant to carry the stones that are necessary for enclosing. To encourage him to preserve the trees, he is to have the whole weedings for the purposes of his farm. There may beside be added a clause, encouraging the tenant to plant trees, by permitting him to cut them down for his own use. And the landlord is to have his choice, either to pay for what are left at the tenant's removal, or to allow him to dispose of them.

Ninth, In a tenant two things are required; first, skill and industry for managing the farm; and, next, money for stocking it sufficiently, without which, skill and industry avail not. With respect

respect to both, our common law errs grossly. As to the first, a farm can never be prudently managed by a plurality; for there it holds, so many men so many minds; and yet, by law heirs-portioners succeed in a lease, as well as in other heritable subjects. To remedy the common law in leases that go to heirs, let it be provided, that the eldest heir-female shall succeed without division; or that the landlord shall have it in his power to chuse any of the heirs-female he pleases.

With respect to the other, our common law is altogether unjustifiable, as it gives the whole stocking to the other children, leaving the bare lease to the heir, without means to stock the farm anew, unless other heritable funds be left beside the lease, which seldom is the case. This is cruelly unjust, both to the heir and to the landlord. The heir has not even the benefit of collation, because it would bring a plurality of conjunct lessees upon the landlord. The heir therefore is in effect totally disinherited; as a bare lease is of no significancy without money or credit. The injustice with regard to the landlord is no less flagrant, who has thus a tenant imposed on him, from whom no rent can be expected. To preserve the lease and stocking united, which must be done by paction since law is defective, let a sum be specified in the lease, such as may be sufficient for stocking the farm; which sum the heir shall be intitled to demand from his predecessor's representatives,

representatives, unless the farm be left to him with a stocking equal in value. And the clause may be conceived in some manner like what follows. "And considering that if the said A. B. die during the currency of this lease, his whole moveables, not excepting the stocking of his farm, will fall by law to his other children, by which it may happen, that nothing is left to the heir but the naked lease, without a stocking or money to purchase it; therefore, to prevent this hardship, equally prejudicial to the heir and to his landlord, it is expressly covenanted, notwithstanding the time of endurance above specified, That this lease shall fall and be extinct by the said A. B.'s death, unless he make good to his heir effects heritable or moveable to the extent of Sterling, the parties being sensible, that a stocking proper for this farm cannot be of value less than the said sum."

Tenth, To render the removing of tenants at the expiry of the lease more easy and certain than it is by our law, and without expence to either party, I propose the following article. Supposing a lease for nineteen years to be agreed on at a rent of L. 50, let one, two, or three years be added, binding the tenant to pay an additional rent for these years, a half more for example, or double. But with a proviso, that the tenant shall be at liberty to remove at the end of the
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nineteen years, upon notifying to his landlord, three months before, his intention to remove.

ARTICLE IV.

PLANTS AND ANIMALS COMPARED.

ANIMALS are provided with various powers corresponding to their destination; some for supporting the animal frame, some for gratifying desire. Plants, in all appearance, have no feeling of pleasure nor of pain; and consequently no desires. But they are endowed with powers for preserving vegetable life, as animals are for preserving animal life. Doth not the springing of the seed, the motion of the sap, the production of leaves, flowers, fruit, &c. proceed from a power in plants; as the beating of the heart, the circulation of the blood, &c. proceed from a power in animals? There is not an argument for the latter that does not equally conclude for the former.

Next, as to the power of loco-motion. That power is more perfect in animals; but plants possess a share of it, such as is necessary for their well-being: they grow both upward and downward; and in their progress to maturity, they are continually occupying new parts of space. Plants, it is true, cannot, like animals, go out of harms

harm's way ; but it is curious to observe, how they exert that share of loco-motion they are endowed with, to avoid harm. Upon the slightest touch, the sensitive plant shrinks back and folds its leaves ; similar to a snail, which on the slightest touch retires within its shell. A new species of the sensitive plant has been lately discovered. If a fly perch upon one of its flower leaves, it closes instantly, and crushes the insect to death. The nettle never fails to sting the hand that touches it. There is not an article of botany more admirable than a contrivance visible in many plants, to take advantage of good weather, and to protect themselves against bad. They open and close their flowers and leaves, in different circumstances : some close before sunset, some after : some open to receive rain, some close to avoid it. The petals of many flowers expand in the sun ; but contract at night, or on the approach of rain. After the seeds are fecundated, the petals no longer contract. The common goatsbeard closes up its flowers while the sun passes the meridian. The pimpernel expands its leaves at sunset, and closes them at sunrise. All the trefoils may serve as a barometer to the husbandman : they always contract their leaves on an impending storm. Some plants follow the sun, some turn from it. Most discous flowers follow the sun ; which has been long observed of the sun-flower, while young and tender. The leaves of the mal-

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low tribe follow daily the course of the sun, from east by south to west. Many plants on the sun's recess vary the position of their leaves; which is stiled the *sleep of plants*. Every botanist, after Pliny, has observed this in a field of clover. A singular plant was lately discovered in Bengal. Its leaves are in continual motion all day long; but when night approaches, they fall from an erect posture down to rest*.

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* This curious property stiled the *sleep of plants* deserves further illustration by an induction of particulars. Yellow goatbeard flowers in June. It expands its flowers about three or four in the morning, and closes them about nine or ten forenoon. The flowers of smooth succory hawkweed are expanded from four in the morning till noon. The African sowthistle with a poppy leaf, expands its flowers between four and six in the morning, and closes them about three hours after. The flowers of the day-lilly, expand about five in the morning, and close about seven or eight in the evening. Wild-poppy with a naked stalk and a yellow sweet-smelling flower, expands its flowers at five in the morning, and closes them at seven in the evening. Bindweed a little blue convolvulus, expands its flowers between five and six in the morning, and closes them in the afternoon. Rose-coloured goatbeard expands its flowers between five and six in the morning, and closes them about eleven forenoon. Dandelion flowers early in the spring, and again in the autumn. It expands at five or six in the morning, and closes them at eight or nine forenoon. Narrow-leaved bushy hawkweed, expands about six in the morning, and closes about five afternoon. Succory-leaved mountain-hawkweed, has its flowers expanded from six in the morning

A plant has a power of directing its roots for procuring food. A quantity of fine compost for flowers, happened to be laid at the root of a full grown

morning till five afternoon. The garden-hawkweed with deep purple flowers, expands from six or seven in the morning till three or four afternoon. The tree sowthistle, common in corn-fields, flowers in June, July and August, expands about six or seven in the morning, and closes between 11 and 12 forenoon. The other species of the sowthistle; follow nearly the same course. Garden-lettuce expands about seven in the morning, and closes about ten forenoon. Hawkweed flowers in July or August. It expands about seven in the morning, and keeps expanded till about three in the afternoon. Bushy-hawkweed with broad rough leaves, flowers June and July; is expanded from about seven in the morning till one or two afternoon. Branched-spiderwort with a small flower, expands about seven in the morning, and closes between three and four afternoon. White water-lilly grows in rivers, ponds, and ditches; and the flowers lye on the surface of the water. At their time of expansion, about seven in the morning, the stalk is erected, and the flowers raised above the surface of the water. In this situation, it continues till about four in the afternoon, when the flowers sink to the surface of the water and close. Marygold with indented leaves, has its flowers expanded from seven in the morning till three or four afternoon. Linnæus observes of this plant, that if its flowers expand later than their usual time, it will most assuredly rain that day. The male pimpernel, flowers in June, and continues to flower three months: is expands about eight in the morning, and closes not till past noon. The blue-flowered pimpernel with narrow leaves, observes nearly the same time. The proliferous pink expands its flowers about

grown elm ; where it lay neglected three or four years. When moved, in order to be carried off, there appeared a net-work of elm-fibres spread through the whole heap. No fibres had before appeared at the surface of the ground. The red whortleberry, a low evergreen plant, grows naturally on the top of our highest hills, among stones and gravel. This shrub was planted as an edging to a rich border, under a fruit-wall. In two or three years, it over-ran the adjoining deep-laid gravel-walk ; and seemed to fly from the border, in which not a single runner appeared. Were our London aldermen equally temperate, they might partake of turtle and venison with safety. An effort to come at food in a bad situation, is extremely remarkable in the following instance. Among the ruins of Newabbey, formerly a monastery in Galloway, there grows on the top of a wall, a plane-tree about twenty feet high. Straited for nourishment in that barren situation, it several years ago directed roots

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about eight in the morning, and closes them about one afternoon. The flowers of wild succory, open about eight forenoon, and keep expanded till about four afternoon. Wild marygold has its flowers expanded from nine in the morning till three afternoon. The purple-spurry flowers in June, expands between nine and ten in the morning, and closes between two and three afternoon. Common purslain expands about nine or ten in the morning, and closes an hour after. The lesser water plantain opens its flowers about noon.

down the side of the wall, till they reached the ground ten feet below ; and now, the nourishment it afforded to these roots during the time of their descending, is amply repaid, having every year since that time made vigorous shoots. From the top of the wall to the surface of the earth, these roots have not thrown out a single fibre ; but are now united into a pretty thick root.

Plants, when forced from their natural position, are endowed with a power to restore themselves. A hop-plant twisting round a stick, directs its course from south to west as the sun does. Untwist it, and tie it in the opposite direction : it dies. Leave it loose in the wrong direction : it recovers its natural direction in a single night. The leaves of all trees and vegetables, have an upper and an under surface which never vary. Twist a branch so as to invert its leaves, and fix it in that position. If left in any degree loose, it untwists itself gradually, till the leaves be restored to their natural position. What better can an animal do for its well-fare ? A root of a tree, meeting with a ditch in its progress, is laid open to the air. What follows ? it alters its course like a rational being, dips into the ground, furrounds the ditch, rises on the opposite side to its wonted distance from the surface, and then proceeds in its original direction. Lay a wet sponge near a root laid open to the air : the root will direct its course

course to the sponge. Change the place of the sponge: the root varies its direction.

Such animals as are naturally weak, exert their self-motive power to remedy that defect, by joining in society. Plants are not capable of society; but several of them supply their natural weakness, by exerting their self-motive power in a manner that would do honour to an animal. The oeconomy of scandent plants is in that respect admirable. Observe how they direct their course to any thing that can support them. Thrust a pole into the ground, within a moderate distance: a scandent plant directs its course to the pole, lays hold of it, and rises on it to its natural height. A honeysuckle proceeds in its course, till it be too long for supporting its weight; and then strengthens itself by shooting into a spiral. If it meet with another plant of the same kind, they coalesce for mutual support; the one screwing to the right, the other to the left. If a honeysuckle twig meet with a dead branch, it screws from the right to the left. The claspers of briony shoot in a spiral, and lay hold of whatever comes in their way for support. If after completing a spiral of three rounds they meet with nothing, they try again by altering their course.

Nature has also provided a remedy for trees that grow too fast in a fruitful soil. Some form the upper part of the weak and tender stem into a sort of screw; which is stronger than a straight line.

line. This among others is the case of the larix. A tree bent by too fast growing, pushes out all its lateral branches on the convex side, in a direction between perpendicular and horizontal, as if it were expanding wings to raise itself up. There are at Kames, elms that when twenty feet high were bent down by overgrowing, the top almost touching the ground. In that position they continued several years, till they were raised by lateral branches as above described; and they are now perfectly erect.

The œconomy of some water-plants is singular. As the *farina facundans* cannot operate under water, a water-lillie, be the water deep or shallow, pushes up its flower-stems till they reach the surface, and then flowers in open air.

The comparison between plants and animals, may be carried a great way farther. There are powers in every animal, to struggle for health by expelling diseases. All that a surgeon can do in the case of a broken bone, is to restore it to its natural position. Nature performs the cure, by pouring into the broken part a liquid matter, which, hardening into bone, unites the parts firmly together. Sydenham, prince of physicians, defines a fever to be an effort of nature to throw out of the body what is noxious. The provision of nature for restoring a maimed animal, is remarkable in the lobster and crab. The feeling of these animals is at the tip of their claws. When the

the tip of a claw is bruised or broken, the whole claw falls off, and another in its stead quickly arrives at maturity *. Are not yawning, stretching, sighing, weeping, efforts of nature to throw off a burden ? There are similar powers in plants to remedy what is noxious. A wound in a tree is cured like a wound in an animal: the separated parts unite ; and the tree is covered with bark as formerly. If part of a branch or of a root be cut off, the want is supplied by a number of small shoots, issuing from the place where the cut was made.

The foregoing facts exhibit a strong resemblance between plants and animals, with respect to the self-motive power. The motion of the heart in animals, of the arteries, of the intestines, of the lungs, cannot be explained by any known law of mechanism ; and as little, the springing of the seed in plants, the oscillatory motion of the sap, the production of leaves, flowers, fruit, &c. These various effects proceed from a self-motive power in plants, as well as in animals ; and by that power chiefly, are organized bodies distinguished

* Monsieur Bonnet is strangely puzzled to account for this fact. He supposes that numberless embryos of every portion of every claw of a lobster were originally created ; that every lobster, is full of such embryos, so artificially placed, as that when part of a claw is broken off, an embryo corresponding to that part is at hand, which is put in motion in order to repair the loss.

guished from brute-matter. A plant exerts this power without consciousness, because consciousness is not the property of any plant. But so far the resemblance holds, that an animal, though endowed with consciousness, exerts the same power blindly, without being conscious of the exertion. The power is in both exerted uniformly without interruption; and each individual may be considered as a sort of *perpetuum mobile*.

The power that a plant or an animal has to remedy any disorder or hurt, differs from the power of carrying on life, in the following particular, that it is quiescent till there be occasion to exert it: it is exerted by circumstances destructive to the health of the plant or animal; and independent of such circumstances, it would contradict the beauty and order of nature that it should be exerted.

There are other powers in animals termed instinctive, by which they act blindly without any view to consequences: hunger prompts them to eat, and cold to take shelter, without reflection or foresight. Instinctive actions differ from those above mentioned, being attended with consciousness, though not with foresight: a duckling, even where hatched by a hen, goes instinctively into water: it knows where it is going; but knows not for what end. To instinctive powers in animals, there are no resembling powers in plants:

we admit not in plants any knowledge or consciousness. Far less do plants exert any actions that resemble voluntary actions in animals.

After much labour bestowed on botany, and many volumes composed on that subject, it appears very little advanced above infancy: no other science has made so slow a progress. I praise the diligence of our botanists: some of them have great merit. But, as far as I understand, their study has been mostly confined to give names to plants, and to distribute them into classes; not by distinguishing their powers and properties, but by certain visible marks. This is an excellent preparation for composing a dictionary: but it leaves us in the dark as to the higher parts of the science, such as are the most proper to engage a thinking and rational mind. No person who has given attention to the conduct of Providence, can entertain any doubt, that the powers and properties of plants are given for beneficial purposes. Have we not reason to hope, that these purposes will be unfolded, when botanists, tired of dictionary-making, shall soar higher in their inquiries. Then will botany become an interesting science, not inferior to any other in dignity and importance: then shall we have occasion to admire more and more the wisdom of the creation. How pleasant to have it observed, that the humblest plant is framed with no less skill, than the most elevated animal!

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So much upon a comparison between plants and animals with respect to motion. Another comparison occurs, no less curious, and still more interesting, that the external frame is nicely adjusted to the internal, so as to accomplish in perfection the ends of Providence. No one who has studied natural history, but must be sensible of this agreement in the animal creation. How well adapted are the claws of a lion and the talons of an eagle, to their rapacious nature. What sort of figure would an innocent lamb make, or timid dove, with such arms ! The shape of a fish is visibly contrived for moving in water : how absurd would the animal be, if it had an aversion to that element. A duckling waddles by instinct to the first water it sees ; for which it is fitted by its oily feathers : such an instinct in a chicken, would be highly incongruous. The hoof of a horse corresponds to his shallow understanding : fingers would be inconsistent with the use that nature intends him for. Without fingers a man would be a miserable creature : he would always be contriving, but without power to execute*.

This truth would be equally evident in plants, were their nature and qualities as well known as of animals. A plant is an organized being, as well as an animal : if the external frame of the latter

* Wonderfully shallow is the reflection of Helvetius, that the only excellency of a man above a horse, is his having fingers.

latter be adapted to its internal frame, can we doubt of the same œconomy with respect to the former? In whatever manner particles of matter are formed into an organic body, of which we know nothing, one thing is certain, that the organic body acquires a nature very different from that of its constituent particles, and also new powers qualifying it for acting according to its destination. The power of gravity, of resistance, of continuing motion, essential to matter in general, will never by any combination produce any thing but motion; but the power of producing a body similar to itself, inherent in all organic bodies, is far superior to the powers mentioned; and therefore must be a new power added in the formation of every organic body.

As plants were originally created of many species, each species has powers peculiar to itself, which preserve the different species distinct, and consequently preserve uniformity among the individuals of the same species. These powers, variously modified in every different species, are exerted in the propagation of new plants, with leaves, flowers, seed, &c. peculiar to each species. And as a perfect agreement between the external and internal frame of plants, as well as of animals, is undoubtedly the plan of nature, incapable of defect or oversight; it may be taken for granted, that each external part contributes to the well-being of the plant, and that any alteration would

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be hurtful: to exchange, for example, the leaves of an oak and an ash, would be prejudicial to both, perhaps destructive. Were we acquainted with the nature of different plants, we should be able to account for the difference of size, of leaves, of roots, of colour, and of seed. We should also be able to explain why some plants spring early, some late; why some are adapted to a hot climate, some to a cold; why some thrive best in dry soil, some in wet; why some produce flowers before leaves; and why some never shed the leaf.

This speculation opens a wide field for observation and experiment, that may worthily employ the most acute philosophers. Why not then attempt to peep into the nature and constitution of plants? The best we can make of that subject, will, I am afraid, be but conjectural. But fair and rational conjectures, which we may hope for, will give some entertainment to the curious inquirer. If we despair of acquiring such knowledge in the internal construction of plants, as to explain all the differences above mentioned, we may at least hope to discover facts that will illustrate the agreement between external and internal structure. I venture to suggest an instance or two. Some plants draw most of their nourishment from the soil, some from the air. Do not small leaves correspond to the former, and large leaves to the latter? I have seen a house-leek growing vigorously

ously on a dry mud wall, excluding rain entirely from the roots. But it has thick leaves, and many in number, which fit it for drawing its nourishment from the air. It is not the light, nor the sun, that makes plants grow erect, but the appointment of nature. A scandent plant has a tendency to grow erect like other plants; but as it is too weak to stand erect, it has tendrils or clasps, to lay hold of any support within reach. Why do certain trees never shed the leaf, even in this country? Is it not a rational conjecture, that they are fitted by nature to bear cold, and that the cold of this climate does not suspend their power of drawing nourishment all the year round?

Were this important branch of botany diligently studied, I fondly hope, that considerable insight might be obtained into the nature of plants, and possibly into their medicinal effects. By that study, the natural history of plants may become no less instructive and entertaining, than that of animals.

ARTICLE V.

PROPAGATION OF PLANTS.

Equivocal generation is by all philosophers exploded from animal life; but some continue to hesitate with respect to vegetables. Animals, say they, wandering from place to place, can stock the

the earth with their progeny; but plants are fixed to the earth they grow in. It is urged, that plants are never wanting where the soil is proper for them; that islands raised by a volcano at a distance from any shore, are soon covered with grass; that mushrooms and other organized bodies, spring from rotten stumps of trees, where they were never seen before; that various plants rise on the foundation of old houses, when cleared of the rubbish; and that upon liming or dunging, white clover springs up in the very central parts of a wide extended barren moor, though the seed of white clover has not wings to carry it to a distance.

To account for these singular facts, it is held, that both plants and animals were originally organized atoms or embryos, having all necessary parts in miniature; that the earth, the water, the air are full of such atoms, which begin not to unfold themselves into plants or animals, till they happen to meet with a proper *matrix* or *nidus*; that in their original state, they are too minute for any of our senses, but that they become visible by expansion.

What means were employed at the creation to cover the earth with plants, may be conjectured, but is far beyond the reach of evidence. It is to me a rational conjecture, that a number of plants and animals were originally created, and endued with proper powers of generation; and that from these, all the plants and animals existing in the world

world are descended. In that belief, I cannot submit to organized atoms, because there is no evidence of them, and because they are unnecessary. To illustrate this conjecture, I add the substance of a letter I had the pleasure to receive from an eminent naturalist *.

“ The doctrine of equivocal generation was
 “ universally admitted, till about 130 years ago;
 “ not, however, so much by the ancients, as
 “ by the half-enlightened moderns. They saw
 “ mites in cheese; and myriads of flies and creep-
 “ ing things in a dunghill, or a putrid marsh.
 “ Ignorance of the natural history of these ani-
 “ mals, made way for conjecturing that they
 “ were mere spontaneous productions, the effect,
 “ not of generation, but of corruption. This
 “ doctrine indeed was confined to these poor in-
 “ sects, and never was extended to a lion or a
 “ horse. They did not advert, that to form a
 “ maggot and an elephant, require equal power
 “ and wisdom. The same distinction was car-
 “ ried into the vegetable kingdom. Because
 “ no seed appeared to the naked eye in a fern, a
 “ mushroom, or in any of the moss-tribe, it was
 “ asserted, that none existed; and while the oak
 “ and the laurel were dignified with generative
 “ faculties, these humble plants were vilified as
 “ the progeny of putrefaction. Equivocal gene-
 “ ration became thus an asylum for ignorance.

* Dr Walker minister of Moffat.

“ I am clear to banish equivocal generation
“ from vegetables, as well as from animals; and
“ I boldly maintain as a fundamental truth in na-
“ ture, *omne vivum ex ovo*. By the *ovum* in
“ vegetables, I mean, a seed, or any part of a
“ plant that contains a bud, or is capable of
“ forming it. They are in effect the same; be-
“ cause every bud, as well as every seed, con-
“ tains the embryo of a future plant. I know of
“ no other way by which plants are propagated,
“ but by seeds, suckers, and layers. The last is
“ imitated by art, in cuttings, grafting, and ino-
“ culation. Some late experiments are mention-
“ ed of propagating trees by planting their leaves;
“ but I do not believe it.

“ Plants, it is true, are destitute of locomo-
“ tion; and by means of suckers and layers, they
“ can only cover contiguous spots. But nume-
“ rous and wonderful are the expedients, practi-
“ sed by nature to disseminate plants. Some seed-
“ vessels burst with an explosive force, and throw
“ the seed to a distance. This is the case of our
“ whin: did the seeds fall perpendicularly down,
“ they would be suffocated in the heart of an im-
“ penetrable bush. Some seed-vessels open not
“ till wet with rain; but the seeds are found to
“ suffer by drought and to require immediate
“ moisture when sown. The ash and the plane
“ have heavy seeds; but these seeds are supplied
“ with wings: a gale of wind carries them from
“ their

“ their lofty situation to a distance, and they re-
 “ main on the tree till the gale comes. The seeds
 “ of humble plants, that they may rise and re-
 “ move, spread more sail to the wind : the thistle
 “ spreads his beard ; and away he travels to fix
 “ his residence in remote parts. A plant of this
 “ kind, *Erigeron Canadense*, was imported from
 “ Canada about one hundred years ago, into the
 “ Paris garden. It is now spread as a wild plant
 “ over France, Holland, Germany, Italy, and
 “ it is said over Sicily. It is spread to such a de-
 “ gree over the south of England, as to be in-
 “ listed among the indigenous plants. Some
 “ seeds, such as our clot-bur, are of an adhesive
 “ nature : they lay hold of animals that come
 “ near them, and are spread far and near.

“ Many other agents are employed by nature,
 “ to stock the earth with plants. The sea and
 “ rivers waft more seeds than they do sails, from
 “ one part of the world to another. I have
 “ found seeds cast ashore in the Hebrides, that
 “ had been dropt accidentally into the sea among
 “ the West-India islands. The island of Ascen-
 “ sion, is the dross of a volcano of a recent date.
 “ Its immense distance from land, renders its ac-
 “ quisition of seeds difficult and precarious. I
 “ know but of two ways for supplying it with
 “ seeds, one by the waters of the ocean, the o-
 “ ther by birds. By one or other of these ways,
 “ it has got possession of three species of plants
 “ and

“and only three; a singularity no where else
“known *.”

“The animal creation is supported by the vegetable; but in return, vegetables owe much
“of their progress to birds and graminivorous
“quadrupeds, which are prime agents in the dissemination of plants. Many birds live on fruits
“and berries: the pulp is their aliment; and
“they discharge the seeds unimpaired, and spread
“them every where. These seeds are heavy,
“and unprovided with any *apparatus* for flight;
“but the birds serve them for wings. Hence
“may be seen plantations of holly, yew, whitebeam, rowan, spindle-tree, hawthorn, and juniper, formed by the birds of the air, upon impending cliffs and inaccessible precipices. Because the mistletoe grows upon trees, and has no
“flower that can be perceived; it was reckoned
“formerly a product of equivocal generation.
“It was concluded, that its large, round, heavy,
“berries, were not the seeds of the plant, because they might fall to the ground, but never
“could mount up into trees. No berries are
“more palatable to birds of the thrush kind; and
“it is they who plant them on high and distant
“trees.

* In no such island was there ever found an animal that was not imported. And why should we admit spontaneous generation to be more possible in a plant than in an animal?

“ trees. It is extremely remarkable, that the ve-
“ getating power of seeds, instead of being im-
“ paired in the stomach of birds, seems to be
“ fortified. The seeds of the magnolia, import-
“ ed from America, commonly refuse to vegetate
“ under the management of the most skilful gar-
“ deners. But I have heard, that these seeds;
“ when voided by turkies, never fail to grow.
“ It is well known, that the dung of domestic
“ animals; while it fertilizes a garden, fills it
“ with weeds. It approaches to a miracle, that
“ seeds should withstand the power of animal di-
“ gestion which no other vegetable substance
“ can do. Here is a measure laid down by Pro-
“ vidence for the preservation and dissemination
“ of seeds, that I cannot reflect upon without
“ wonder.

“ In order to fill the earth with plants, any o-
“ ther method except by seeds, suckers, and lay-
“ ers, appears to me unnecessary, and therefore
“ improbable. Farewell then to equivocal gene-
“ ration. I can scarce write of it, without be-
“ ing a little ruffled; so ill it corresponds with the
“ more august and comfortable ideas of creation;
“ which have made a principal article of happi-
“ ness in my life.”

So far my correspondent. I join heartily with
him in his conclusion, that the known means for
storing the earth with plants, which are conspi-
cuous marks of designing wisdom, are in all ap-
pearance

pearance so completely adequate, that to search for unknown means, seems to be an idle attempt.

Having thus restored the plan of nature, which in the simplest manner employs seeds as the chief means for propagating plants, we proceed to consider how seeds are formed. Many philosophers, holding it to be incredible, that a plant, or even an animal, should be endowed with a power to produce its own likeness, have embraced an opinion, that all the plants and animals that ever existed, or that ever can exist, were formed originally, not plants or animals, but embryos of those inclosed in an egg or seed, which when deposited in a proper *nidus* or *matrix*, grow up to a plant or animal, and then decay. And to account for future generations, it is held, that every embryo contains within it smaller embryos without end, like cups of different sizes cased one within another. These philosophers must go still farther. To account for each seed producing a tree, and that tree producing seed, it must also be held, that the embryo inclosed in a seed contains smaller embryos decreasing in size without end; and that each of these smaller embryos contains another series of decreasing embryos, also without end. Here are infinites upon infinites, still without end. To avoid the intricacy of infinites upon infinites, some philosophers have varied the system a little, with a view to render it, as they think, more simple, by recurring to organized atoms, exploded
above.

above *. But this system, not to repeat what is said against it above, is only in appearance more simple: it resolves into infinities upon infinities like the former, and is in reality no less intricate. Take any of the supposed embryos, hovering in air, swimming in water, or fixed in earth: give it a proper *matrix*, and let it become a tree with seed. As each seed may produce a tree, and each tree produce seed which may also become trees, it is manifest, that an infinite number of embryos must have been contained in the first embryo, and an infinite number in every one of that infinite number.

That every seed contains an embryo-plant, is a valuable discovery in natural history; but that there is a decreasing series of embryos within every seed, is a mere conceit, assumed without the least appearance of truth. So far is it from holding true that plants within plants subsist in a seed without end, that even the single plant it contains is there in a very imperfect state. The plume and radicle alone subsist in it; and the other parts are produced in the course of growing. But let us give way to the supposition of an infinite series, to see what can be made of it. Writers stop short and leave the reader in the dark, precisely where he needs light the most. A seed is laid in earth; by what mechanical power is vegetation

* See Bonnet upon organized bodies.

vegetation produced and continued during the life of the plant? And by what mechanical power does motion commence in the fœtus of an animal, and the blood circulate? When a seed happens to be inverted in the ground, with its radicle above, and its plume below; what is the mechanic power that makes them wreathe about the seed till the radicle gets into earth and the plume into air*? Unless these particulars can be accounted for mechanically, an embryo must be held a pure vision. A power must be admitted even in the smallest embryo, to expand itself into a plant or animal, where it happens upon a proper nidus. And yet the admission of that power destroys the hypothesis, root and branch. A seed thrown into the ground would rest there for ever, were it not endued with a power to begin vegetation, and to continue it. It grows into a tree: why may not that tree be endued with a power to form its own seed? If so, there is no necessity to go farther back: organized atoms or embryos must vanish, because there is no use for them. Power in a tree to form its seeds, is no more extraordinary than that of sucking juices from

* To ascend and descend is not the ultimate view in these two parts, but to get into the air and earth. As seeds are generally deposited on or near the surface of the ground, the plume ascends and the radicle descends. But place a seed in an inverted flower-pot with earth in it: the radicle ascends and the plume descends: the first pursues his road into the earth; and the other into the air.

from the earth, and converting them into its own substance, a power that every plant is admitted to have. And if plants have power to form seed, there surely can be no hesitation in ascribing the same power to animals. Can any thing be more simple, or more agreeable to the analogy of nature, than that the Almighty, who created plants and animals, should endue them with a power to propagate their kind? Are we not informed of this by eye-sight; and can any solid argument be urged against what we see? Thus the operations of nature, when understood, turn out no less illustrious for their simplicity than for their extensive effects.

I shall close this essay with a passage of another letter from my correspondent above-mentioned. "As for the doctrine of organized atoms diffused through the universe in order to be converted into animals and vegetables, it is not countenanced by any thing within the sphere of my knowledge. No facts are adduced, nor do I recollect any, to support it. I adhere more and more to this plain truth, that all plants and animals are propagated by seeds, or analogous organizations; which are formed out of unorganized matter, by the power of the vital principle of plants and animals, in the way of secretion. By analogous organizations, I mean a bud of a tree, a section of a polypus, and such like organized parts, that are capable like seeds
of

“ of growing up into a complete plant or animal.

“ The secretory power of plants and animals is indeed a wonder. A lyncean anatomist, with his great magnifiers, cannot penetrate the darkness in which it is involved. The transmutation of matter by animal and vegetable secretion, is obvious to every eye. By what means it is performed, seems to be that high legerdemain which nature will never reveal. But if by this power bread and water can be changed into flesh and blood, into bones and sinews, into the Argus' eye on the peacock's tail; if by this power simple water can be converted into the hardest wood, into aromatic flowers and rich fruits; I then cease to wonder, that the same water should be converted into a seed, capable of unfolding itself into a future plant. I require no aid from vagrant organized atoms; I see no assistance they can afford. I dislike a hypothesis that appears not to have any foundation in truth, or even in probability.”



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